Skamania PUD – Carson Water Treatment Plant Upgrade

Project Manual, Volume 2 of 4

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Prepared for:
Public Utility District No. 1 of Skamania County

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Issued for Construction

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SECTION 01 10 00 – SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Work to be performed under this Contract shall consist of furnishing plant, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be provided by the Contractor as though originally so indicated, at no increase in cost to the Owner.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

1.03 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of this Contract comprises the construction of a new one million gallon per day water filtration plant which includes:

1. Modifications to the influent and effluent pipelines

2. Repurposing the existing Filtered Water Pump Station for use as a Raw Water Pump Station.

3. Skid-mounted membrane equipment housed in a weather-resistant enclosure provided by the manufacturer

    a. The basis of design is the Aria Filtra “Aria FAST T96” containerized membrane filtration system. Bids may propose an approved equal membrane system; however, any alternate system must match or exceed the performance and functional integration of the basis of design. The contractor is responsible for all design adjustments and additional components (e.g., external filtrate pumping systems, additional tanks, electrical/control modifications) necessary for an alternate system, at no extra cost to the Owner.

4. A pre-engineered metal building containing:

    a. Control room and lab

    b. Bathroom

    c. Chemical storage and feed equipment

5. Retrofit of the existing water treatment plant for backwash clarification

6. Construction of a new Chlorine Contact Tank

7. Retrofit of the existing pond/basin for solids storage

8. An underground Clean-In-Place storage tank

B. The following is a list of additive bid items. These items may be included in the project if the District's budget is sufficient.

1. The covered canopy, which extends from the Chemical Building to the membrane treatment units

2. Standby power generator and automatic transfer switch. Provide and install the concrete equipment slab and electrical conduit for the standby power generator and automatic transfer switch as part of this Contract, irrespective of the Owner's acceptance of the associated additive bid item.

C. The Work is located at the Owner's water filtration plant, approximately 1/4-mile south of the intersection of Kid Ln. and Old Detour Rd. in the town of Carson, Washington.

1.04 CONTRACT METHOD

A. The Work hereunder will be constructed under a single lump sum contract.

1.05 WORK BY OTHERS

A. Where 2 or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the Owner will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the Owner may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount , and in manner and at time that the Owner may determine. No Owner determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The Contractor shall conduct its operations so as to cause a minimum of interference with the work of such other contractors and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

B. Interference With Work On Utilities**:** The Contractor shall cooperate fully with all utility forces of the Owner or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the Work, and shall schedule the Work so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.06 WORK SEQUENCE

A. The Contractor's attention is directed to the fact that no interruption in the flow can be accommodated during high water demand, typically July 15 through August 15. The Contractor shall so schedule its construction operations that no interference with the operation of the plant will occur during this critical period.

B. Access to the site is limited to the hours of 7:00 am to 5:00 pm.

1.07 CONTRACTOR USE OF SITE

A. The Contractor's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

1.08 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the Contractor shall not remove from service, de-energize, or modify settings for any existing operating tank, pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the Engineer.

B. Where the Work requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the Contractor shall submit a detailed outage plan and schedule for the Engineer’s approval a minimum of 2 weeks in advance of the time that such outage is planned.

C. A completed System Outage Request form (blank furnished by the Engineer) shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents.

D. The Engineer shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

E. The Contractor shall provide written confirmation of the shutdown date and time 2 working days prior to the actual shutdown.

F. Reference Section 01 14 00 – Construction Constraints for allowable outage durations

1.09 OWNER USE OF THE SITE

A. The Owner may utilize all or part of the existing facilities during the entire period of construction for the conduct of the Owner's normal operations. The Contractor shall cooperate and coordinate with the Owner to facilitate the Owner's operations and to minimize interference with the Contractor's operations at the same time. In any event, the Owner shall be allowed access to the Site during the period of construction.

1.10 PROJECT MEETINGS

A. Preconstruction Conference

1. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the Contractor’s Project Manager, its superintendent, and its subcontractors as the Contractor deems appropriate. Other attendees will be:

a. Engineer and the Resident Project Representative.

b. Representatives of Owner.

c. Governmental representatives as appropriate.

d. Others as requested by Contractor, Owner, or Engineer.

e. The Contractor shall bring the preconstruction conference submittals in accordance with Section 01 33 00 – Submittal Procedures.

2. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the Contractor prior to the meeting date. However, the Contractor should be prepared to discuss all of the items listed below.

   a. Status of Contractor's insurance and bonds.

   b. Contractor's tentative schedules.

   c. Transmittal, review, and distribution of Contractor's submittals.

   d. Processing applications for payment.

   e. Maintaining record documents.

   f. Critical work sequencing.

   g. Field decisions and Change Orders.

   h. Use of Site, office and storage areas, security, housekeeping, and Owner's needs.

   i. Major equipment deliveries and priorities.

   j. Contractor's assignments for safety and first aid.

   k. Daily Report Form which the Engineer will furnish.

   l. Submittal Transmittal Form which the Engineer will furnish.

   m. Tracking of long lead equipment and materials

3. The Engineer will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

4. The Contractor and its subcontractors should plan on the conference taking no less than 0.5 a working day. The preconstruction conference will cover the items listed in paragraphs 2 and 3, and a review of the Drawings and Specifications, in extensive detail, with the Engineer and the Owner.

B. Progress Meetings

1. The Engineer will schedule and hold regular on-Site progress meetings at least weekly and at other times as requested by Contractor or as required by progress of the Work. The Contractor, Engineer, and all subcontractors active on the Site shall attend each meeting. Contractor may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

2. The Engineer will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the Contractor shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00– CONSTRUCTION CONSTRAINTS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Work shall be scheduled, sequenced, and performed in a manner which minimizes disruption to the public and to the operation and maintenance of existing facilities.

B. The Contractor shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 01 32 14 – Barchart Construction Schedule.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 32 14	Barchart Construction Schedule
01 50 10	Protection of Existing Facilities

1.03 EXISTING PLANT

A. The Work shall be executed while the existing water treatment plant is in operation. Operation of the existing plant shall not be jeopardized nor shall the efficiency of water treatment be reduced as a result of the execution of the Work.

B. Unless indicated otherwise, temporary pumping, piping, power, lighting, controls, instrumentation, alarms, security devices, and safety devices shall be provided by the Contractor whenever its activity or interruption due to its activity affects the existing facility.

C. The construction constraints in this Section do not include every item affecting the completion of the Work but are intended to describe the sequence of critical events necessary to minimize disruption to the ongoing treatment plant processes and to ensure compliance with Permit requirements. It shall be understood and agreed by the Contractor that the critical events described are not inclusive and that additional items of Work not included may be required to minimize disruption and ensure compliance. Deviation from or modification of these suggested sequences is permitted if techniques and methods known to the Contractor will result in reducing disruption to the facility operation and maintaining treatment efficiency, and if deviation is approved in advance by the Engineer.

1.04 OPERATION OF PLANT EQUIPMENT

A. Operational functions or shutdown of the existing plant required to facilitate Contractor's operation will be done by the Owner's personnel only.

B. The plant operation and maintenance personnel will cooperate in every way that is practical in order to facilitate Contractor's operation. However, certain shutdown and connections may only be permissible at times other than normal working hours such as nights or weekends. No additional payment will be made to the Contractor for any night, weekend, or holiday premium or overtime payments.

C. If it becomes necessary for the proper operation or maintenance of portions of the plant, the Owner may require the Contractor to reschedule an approved shutdown. The Contractor shall then reschedule its operations so there shall be no conflict with necessary operations or maintenance of the plant. The Contractor shall, within 2 Days, furnish the Engineer a revised outage request and a plan for rescheduling the shutdown in accordance with the requirements of the construction schedule.

1.05 OUTAGE REQUESTS

A. Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities may require the temporary outage or bypass of existing treatment processes or facilities. In such cases, the Contractor shall coordinate Work with the Engineer as described below. The Contractor shall submit a detailed outage plan and time schedule for construction activities which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, structure, road, or other facilities from service.

B. The outage plans shall be submitted to the Engineer for acceptance a minimum of 2 weeks in advance of the time that such outages are required. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section. The outage plan shall describe the Contractor's method for preventing bypassing of other treatment systems; the length of time required to complete the operation; any necessary temporary power, controls, instrumentation, or alarms required to maintain control, monitoring, and alarms for the treatment plant processes; and the manpower, plant, and equipment which the Contractor shall provide in order to ensure proper operation of associated treatment units. Costs for preparing and implementing the outage plans shall be the responsibility of the Contractor as part of the Work.

C. The Contractor shall not begin an alteration affecting existing facilities until specific written approval has been granted by the Engineer in each case.

D. The Engineer will coordinate the Contractor's planned procedure with the treatment facility personnel. The Engineer has the authority to modify any proposed shutdown procedures if such procedures would adversely impact the plant operations.

E. Reference Section 01 10 00 – Summary of Work for outage instructions.

F. The contractor shall also account for plant recovery time between interruptions. The acceptable duration of seasonal interruptions and minimum recovery time are summarized below:

Schedule	**Maximum Allowable Interruption**	**Minimum Recovery Between Interruptions**
June 15 – July 14	24 hours	48 hours
July 15 – August 15	prohibited	
August 16 – September 15	24 hours	48 hours
September 16 – November 15	48 hours	24 hours
November 16 – March 15	3 days	24 hours
March 16 – June 14	48 hours	24 hours

1.06 TEMPORARY CONNECTIONS

A. Making connections to existing facilities or other operations that interfere with the operation of the existing equipment shall be thoroughly planned in advance, and required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall be completed as quickly as possible and with as little delay as possible and shall proceed continuously (24 hours a day and seven days a week) if necessary to complete modifications and/or connections in the minimum time.

B. The cost of any temporary facilities and night, weekend, or holiday activity and overtime payments required during process interruptions shall be included in the Work.

C. Temporary facilities and piping shall be located to minimize interference with Contractor's construction facilities and Owner's operation and maintenance of the wastewater treatment plant. Unless otherwise indicated, each temporary pipeline shall be of the same size as its connection to the existing or permanent facility at the downstream end of the pipeline. Piping materials shall be suitable for the material being conveyed and be as required in the Contract Specifications.

D. When temporary electrical power, controls, instrumentation, or alarms are required for routine continuous operations of existing or new equipment, the Contractor shall provide the necessary equipment and appurtenances. Prior to installing said equipment and appurtenances, Contractor shall furnish a submittal on the proposed components and installation for Engineer's review and approval.

E. A plan showing the size and location of the temporary facilities and piping shall be submitted to the Engineer at the same time as the outage plan required under this Section. Costs for design, provision, operation, and removal of temporary facilities and piping shall be part of the Work.

1.07 CONSTRUCTION SEQUENCING

A. General: It is the Contractor's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall Work.

B. Construction activities shall be scheduled and sequenced to ensure continuous operation of the existing treatment facilities. The Contractor's scheduling shall develop construction sequencing so that the Work will not adversely impact treatment. The Contractor shall be responsible for development of the construction sequencing. In implementing the construction sequencing, the Contractor shall maintain the existing facilities in service until new facilities are constructed and are operational to supplement the existing capacity. When new facilities are operational, the existing facilities may be taken out of service. The following general guidelines shall be used by the Contractor in planning the sequence of construction.

1. Safe working conditions for personnel shall be maintained during rehabilitation, modification, and demolition Work. The foregoing includes at least proper trench excavation, the provision of temporary equipment guards, supports, warning signs, walkways, covers over openings, handrailing, and protection of electrical equipment and power supply.

2. Temporary facilities shall be constructed in accordance with applicable codes and regulations to operate safely and properly.

3. Valves to be temporarily shut off during the Work shall be tagged as such and shall be wired shut with a crimped lead seal and padlocked. Shut off shall be supervised by facility staff.

4. Electrical and mechanical equipment shall be similarly shut down and locked out, tagged out.

C. Phase 1

1. Membrane container startup, acceptance testing, Owner approval, and Department of Health approvals must be achieved before proceeding to Phase 2.

2. The Phase 1 piping arrangement is indicated on the drawings and includes:

a. Installation of a coagulant dosing system in the existing raw water meter vault

b. A connection to the existing raw water pipeline which will route flow to the membrane system using gravity flow from Bear Creek, i.e, bypassing the Raw Water Pump Station.

c. Two vertically oriented blind flanges can be used to route filtered water back to the raw water pipeline during commissioning to recirculate during testing. The Contractor shall provide a tee, valve, and piping to route filtered water to the solids handling basin.

d. Reverse Flow piping shall be installed to send backwash waste to the existing Solids Handling Basin if the Contractor deems it constructible. If one or both Solids Handling Basin's cannot be constructed, the Contractor will be required to pump and treat backwash water which can be discharged to the stormwater flow spreader.

e. Constraints include:

1) The Contractor cannot make a direct connection to the existing Filtered Water Pump Station (new Raw Water Pump Station) during Phase 1.

2) The Contractor cannot make a connection to the existing filtered water pipeline during Phase 1 unless an air-gap is provided.

3) The CIP Waste Storage Tank should be constructed, as well as the septic/drainfield, so that Clean-In-Place waste can be discharged properly.

4) The stormwater system flow spreader shall be installed.

5) The existing water treatment plant filters will need to be backwashed during construction; the Solids Handling Basin, or a portion thereof will need to remain in service. Alternatively, the Contractor can pump and treat backwash water and discharge it to the stormwater flow spreader.

3. Once Phase 1 is complete, the Contractor shall place the membrane system into full service so that:

a. Demolition of the existing filtration systems can be completed to accommodate conversion to backwash clarification.

b. The existing filtered water tank and pump station can be converted to the new Raw Water Pump Station.

1.08 PERMITS

A. The Contractor shall abide by the conditions of permits and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the Work by the Owner.

B. Conditions affecting the Contractor are found in the following permits.

1. Building Permit – by Owner.

2. Skamania County Septic and Drainfield Permit – Submitted by Owner, finalized by Contractor.

a. Design has been submitted to the County and permit is good for 2 years from February, 2026

3. National Scenic Area – Clear and Grade Permit – By Owner.

4. Electrical, plumbing, HVAC and other trade permits as required – by Contractor.

5. NPDES permits for discharges of water used for startup, disinfection, or cleaning – by Contractor.

6. Erosion Control – by Contractor.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00 - MEASUREMENT AND PAYMENT

PART 1 -- GENERAL

1.01 SUMMARY

A. Measurement is described under each bid item in this Section.

B. Payment for the various items on the Bidding Schedule, as further specified herein, shall include all compensation to be received by the Contractor for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work being described, as necessary to complete the various items of the work all in accordance with the requirements of the Contract Documents, including all appurtenances thereto and including all costs of compliance with the regulations of public agencies having jurisdiction, including safety and health requirements of the Occupational Safety and Health Administration of the U. S. Department of Labor (OSHA). No separate payment will be made for any item that is not specifically set forth in the Bidding Schedule, and all costs therefore shall be included in the prices named in the Bidding Schedule for the various appurtenant items of work.

C. Indirect costs, such as supervision and overheads, profit, the general conditions specified in the Contract, all shall be allocated to each bid item as applicable for work defined in the bid item. No separate payment will be made to the Contractor for these items.

1.02 BID ITEM MEASUREMENT AND PAYMENT

A. The Bidding Schedule is divided into numerous bid items whose definitions follow. Bid Item Nos. 1, Nos. 2, and represent the entire scope of work covered by the Contract Documents.

B. Bid Item No. #2, Trench Excavation Safety Systems (Lump Sum):
   1. As required by RCW 39.04.180, this bid item shall include all cost for work of providing adequate safety systems for trench excavation which exceed a depth of four feet to comply with the requirements of the Washington Industrial Safety and Health Act, Chapter 49.17 RCW.
   2. The costs of trench safety systems shall not be considered as incidental to any other contract item and any attempt to include the trench safety systems as an incidental cost is prohibited.
   3. Measurement will be in accordance with a reasonable apportionment of the work as established in the Schedule of Values.

C. Payment will be based on the percentage of completion of each item in the Schedule of Values.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 73 – SCHEDULE OF VALUES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed and incorporated into the Barchart Construction Schedule in accordance with the requirements of Section 01 32 14 – Barchart Construction Schedule.

B. Monthly progress payment amounts will be determined from the monthly progress updates of the Schedule activities.

C. Develop the Schedule of Values independent of but simultaneous with the development of the Schedule activities and logic.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 32 14	Barchart Construction Schedule
01 10 00	Summary of Work

1.03 PRELIMINARY SCHEDULE OF VALUES

A. Submit a preliminary Schedule of Values for the major components of the Work at the Preconstruction Conference in accordance with the requirements of Section 01 10 00 – Summary of Work.

B. At a minimum, submit proposed values for the following major Work components:

1. Mobilization: 5% percent of Contract Price;

2. The total value of electrical Work;

3. The total value of instrumentation and control Work;

4. The total value of protective coatings Work;

5. The total value of yard mechanical Work inclusive of excavation, pipe installation, testing and backfill of pipe, and all incidental Work associated with underground pipe installations;

6. The total value of mechanical Work:

   a. Exclusive of yard mechanical Work included in Item 5 above, but including piping, valves, equipment, tanks, and appurtenances at new and existing structures;

   b. Break down this total value into separate values for each new and existing structure constructed or modified as a part of the Work;

7. The total value of structural reinforced concrete Work:

a. Inclusive of excavation, dewatering, subgrade preparation, backfill, and incidental Work for new structures;

b. Break down this total value shall be broken down into separate values for each new structure constructed as a part of the Work;

c. Miscellaneous and minor concrete Work may be listed as one item in this breakdown;

8. The total value of metal buildings:

a. Inclusive of architectural Work, doors, windows and other incidental systems and features;

b. Break down, this total value shall be broken down into separate values for each pre-engineered metal building;

9. The total value of the solids pond upgrade;

10. The total value of site civil Work, inclusive of clearing and grubbing, demolition, paving, gravel surfacing, fencing and gates, septic drain field, grading and drainage Work, and;

11. The total value of landscaping;

12. The total value of other Work not specifically included in the above items.

C. Review and Revisions

1. The Contractor and Engineer shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the Engineer, these are necessary to establish fair and reasonable allocation of values for the major Work components.

2. Front-end loading will not be accepted.

3. The Engineer may require reallocation of major Work components from items in the above listing if in the opinion of the Engineer such reallocation is necessary.

4. This review and any necessary revisions shall be completed within fifteen (15) Days from the date of Notice to Proceed.

1.04 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to the Engineer within thirty (30) Days from the date of Notice to Proceed.

B. Base the detailed Schedule of Values on the accepted preliminary Schedule of Values for major Work components.

C. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the Schedule activities, furnish a sufficiently detailed breakdown in order to meet this requirement.

D. The Engineer will be the sole judge of acceptable numbers, details and description of values established.

E. If, in the opinion of the Engineer, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified by the Engineer.

F. Submit the minimum detail of breakdown of the major Work components as follows; furnish greater detail if requested by the Engineer:

1. Mobilization: no breakdown required;

2. Section 01 32 14 – Barchart Construction Schedule: break down by submittal;

3. Break down the electrical Work by structure and yard facilities, as follows:

    a. Break down structures electrical Work into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations, and lighting; and,

    b. Break down yard facilities electrical Work by duct bank designation and substations;

4. Break down instrumentation and control Work by structure;

5. Protective Coating Work:

    a. Break down protective coating Work by structure and yard area;

    b. Where specific coating Work at structures or yard areas may be critical to performing the Work in order to meet milestone and Contract Times, such Work shall be included as individual pay and Schedule activity items;

6. Yard Piping Work:

    a. Break down into individual pipelines running from and to Contract termination points.

    b. Each pipeline shall be an individual pay item unless otherwise allowed by the Engineer.

7. Break down mechanical Work within each structure in order to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.

8. Break down concrete structures into excavation, subgrade preparation, and appurtenant pre-foundation Work, concrete foundation construction, slabs on grade, walls/columns, suspended slabs, stairs, and the like (provide sufficiently detailed breakdown in order to accommodate necessary Schedule detail), hydrostatic structure testing, where required, and backfill.

9. Break down pre-engineered metal buildings into building frame erection, roofs, decks, siding and soffit Work, insulation, doors/windows/louvers, and other items determined to be necessary for the establishment of pay and schedule activity items.

10. Break down the ponds into excavation, earthwork subgrade protection and preparation, concrete base, sloped concrete, access ramps/roadways, and other items determined to be necessary for the establishment of pay and schedule activity items.

11. Break down civil site Work into individual drainage piping, drainage structures, site concrete, paving, gravel surfacing, demolition, excavation cut and fill, removal of existing pipe, clearing and grubbing, fencing and gates, septic drain field, and other items determined to be necessary for the establishment of pay and schedule activity items.

12. Breakdown of landscaping into planting, soil amendments and irrigation.

13. Break down pre-commissioning and commissioning based on completion milestones for each.

14. Break down other Work not specifically included in the above items, as necessary for the establishment of pay and schedule activity items.

G. Adjustments and Acceptance

1. The Contractor and Engineer shall meet and jointly review the detailed Schedule of Values within 35 Days from the date of Notice to Proceed, at which time the value allocations and extent of detail shall be reviewed in order to determine if necessary adjustments to the values are required, and to determine if sufficient detail has been proposed in order to allow acceptable cost loading of the Schedule activities.

2. Make necessary adjustments to the value allocation or level of detail, and submit a revised detailed Schedule of Values within forty (40) Days from the date of Notice to Proceed.

3. Following acceptance of the detailed Schedule of Values, incorporate the values into the Schedule.

4. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the Schedule activities, where interfacing these two (2) documents will require changes to each document.

5. Schedule activities may need to be added to accommodate the detail of the Schedule of Values, and Schedule of Value items may need to be added to accommodate the detail of the Schedule activities.

6. Where such instances arise, propose changes to the Schedule of Values and to the Scheduled activities in order to satisfy the Engineer.

1.05 CHANGES TO SCHEDULE OF VALUES

A. Changes to the Schedule which additional activities not included in the original schedule but included in the original Work (schedule omissions) shall have values assigned as approved by the Engineer.

B. Reduce other activity values in order to provide equal value adjustment increases for added activities, as approved by the Engineer.

C. In the event that the Contractor and Engineer agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

1.06 LIQUIDATED DAMAGES

A. The Schedule of Values information is an integral part of the scheduling and reporting under Section 01 32 16 – Barchart Construction Schedule and the progress payment information.

B. As such, it is critical information to evaluating progress and the proper planning of the Owner's and Engineer's Work related effort as well as their financial obligations associated with the Project.

C. Accordingly, if a submittal required by this Section is found to be incomplete or is submitted later than required, the Owner will suffer financial loss and, accordingly, liquidated damages will be assessed against the Contractor in accordance with Article 4 of the Agreement.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 14 – BARCHART CONSTRUCTION SCHEDULE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall schedule the Work in accordance with the Contract Documents.

B. Where submittals are indicated, submit a PDF document.

C. The Contractor is alerted to Section 01 14 00 – Construction Constraints.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 14 00	Construction Constraints
00 80 00	Supplementary Conditions of the Construction Contract

1.03 INITIAL SCHEDULE SUBMITTALS

A. The Contractor shall submit 2 schedule documents at the Preconstruction Conference that shall serve as the Contractor's Plan of Operation for the initial 60 Day period of the Contract Times and shall identify the manner in which the Contractor intends to complete Work within the Contract Time. The Contractor shall submit a 60 Day Plan of Operation Bar Chart Schedule and a Project Overview Bar Chart Schedule for Work as indicated below.

1. 60 Day Bar Chart Plan of Operation Schedule: The bar chart shall show the Contractor's early activities (mobilization, permits, submittals necessary for early material and equipment procurement, submittals necessary for long lead equipment procurement, scheduling submittals, initial site work, and other submittals) required in the first 60 Days).

2. Project Overview Bar Chart Schedule: The Bar Chart shall indicate the major components of the Work and the sequence relations between the major components and subdivisions of major components. The bar chart schedule shall indicate the relationships and time frames in which the various components of the Work will be made substantially complete and placed into service in order to meet the Contract Times. Sufficient detail shall be included for the identification of subdivisions of major components according to such activities as mobilization, site dewatering, excavation, demolition, yard piping installation, placement of structural backfill, final site grading, and other important Work for each major item within the overall project scope. Planned durations and start dates shall be indicated for each work item subdivision. Each major component and subdivision component shall be accurately plotted on time scale sheets not to exceed 36-inches by 60-inches in size. Not more than 4 sheets shall be employed to represent this overview information.

B. The Engineer and the Contractor shall meet to review and discuss the 60 Day Plan of Operations and Project Overview Schedules within 5 Days after submittal. The Engineer's review and comment on the schedules will be limited to conformance to the Contract Documents. The Contractor shall make corrections to the schedules necessary to comply with requirements and shall adjust the schedules to incorporate any missing information requested by the Engineer.

1.04 CHANGE ORDERS

A. Upon approval of a change order or upon receipt of authorization to proceed with additional Work, the change shall be depicted in the next submittal of the Project Overview Bar Chart Schedule.

1.05 STATUS REPORTING

A. The Contractor shall furnish monthly Project Overview Bar Chart Schedules and written narrative reports in the form indicated below.

B. The Project Overview Bar Chart Schedule shall be a summary of the current construction schedule for major project components (original and as updated and adjusted throughout the entire construction period). It shall be limited to not more than 4 pages and shall be a PDF document. The major project components shall be represented as time bars which shall be subdivided into various types of Work including dewatering, excavation, demolition, yard piping, placement of structural backfill, and final site grading.

C. Each major component and subdivision shall be plotted accurately on a time scale consistent with the early start and finish activity information contained in the latest update of the schedule. In addition, a percent completion shall be listed for each major component and subdivision. The Contractor shall amend the Project Overview Bar Chart Schedule as necessary to include any additional detail required by the Engineer. The Contractor shall include any additional information requested by the Engineer at any time during construction.

D. The Contractor shall prepare monthly written narrative reports of the status of the project for submission to the Engineer. Status reports shall include:

1. The status of major project components (percent complete and amount of time ahead or behind schedule) and an explanation of how the project will be brought back on schedule if delays have occurred.

2. The progress made on critical activities indicated on the construction schedule.

3. Explanations for any lack of Work on critical activities planned to be performed during the last month.

4. Explanations for any schedule changes, including changes to the logic or to activity durations.

5. A list of the critical activities scheduled for the next 2 months.

6. The status of major material and equipment procurements.

7. The value of materials and equipment properly stored at the Site but not yet incorporated into the Work.

8. Any delays encountered during the reporting period.

9. An assessment of inclement weather delays and impacts to the progress of the Work.

10. The Contractor may include any other information pertinent to the status of the project.

11. The Contractor shall include additional status information requested by the Engineer.

1.06 INCLEMENT WEATHER PROVISIONS OF THE SCHEDULE

A. The construction schedule shall include lost days on the construction schedule due to inclement weather. Inclement weather delays shall be determined in accordance with Section 00 80 00 - Supplementary Conditions of the Construction Contract.

1.07 LIQUIDATED DAMAGES

A. If any submittal required by this Section is determined by the Engineer to be incomplete or is submitted later than required, the Owner will suffer financial loss and, accordingly, liquidated damages may be assessed against the Contractor in accordance with the Agreement.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Wherever submittals are required by the Contract Documents, submit them to the Engineer.

B. Within 14 Days after the date of commencement as stated in the Notice to Proceed, submit the following items for review:

1. Submittal Schedule

a. Submit a preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("or equal") submittals listed in the Bid.

b. Base the schedule of submittals on Contractor's priority, planned construction sequence and schedule, long-lead items, and size of submittal package.

c. Allow time for resubmittals.

2. Submit a list of permits and licenses the Contractor shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

C. Federal Funding Requirements

1. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). All iron and steel, manufactured products, and construction materials permanently incorporated into the project must be manufactured in the United States. To ensure compliance, upon Notice to Proceed (NTP), the Contractor shall submit a Master Submittal List clearly indicating which materials are subject to BABA, which may require waivers, and which are proposed for inclusion in the De Minimis Log. Certification letters from manufacturers must accompany all submittals for BABA-covered materials. The Contractor is responsible for maintaining a BABA Tracking Log throughout the project lifecycle, and all documentation must be made available for audit and review. Failure to comply with these requirements may result in enforcement actions, including cost recovery or disallowance of federal funding.

2. The project is subject to American Iron and Steel (AIS) requirements under the Consolidated Appropriations Act of 2017 (Section 746 Division A of Title VII) mandating for all iron and steel products to be produced in the United States. BABA requirements for Iron and Steel are equivalent to those under AIS.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 10 00	Summary of Work
01 29 73	Schedule of Values

01 32 14	Barchart Construction Schedule
01 52 00	Field Office, Equipment, and Services
01 60 00	Products, Materials, Equipment, and Substitutions
01 77 00	Project Closeout

1.03 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference of Section 01 10 00 – Summary of Work, submit the following items to the Engineer for review:

1. a revised schedule of Shop Drawings, Samples, and proposed Substitution ("or-equal") submittals listed in the Bid;

2. a list of permits and licenses the Contractor shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit;

3. a preliminary schedule of values in accordance with Section 01 29 73 – Schedule of Values;

4. a 60-Day plan of operation in accordance with Section 01 32 14 – Barchart Construction Schedule;

5. a detailed layout of the field office required under Section 01 52 00 – Field Office, Equipment, and Services; the office shall not be shipped to the Site until the layout is approved.

1.04 SHOP DRAWINGS

A. Wherever called for in the Contract Documents or where required by the Engineer, furnish one copy plus one reproducible copy of each Shop Drawing submittal.

B. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items.

C. Whenever the Contractor is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in Washington.

D. Transmittal Form

1. Shop Drawing submittals shall be accompanied by the Engineer's standard submittal transmittal form, a reproducible copy of which is available from the Engineer.

2. A submittal without the form, or where applicable items on the form have not been completed, will be returned for resubmittal.

E. Organization

1. Use a single submittal transmittal form for each technical specification Section or item or class of material or equipment for which a submittal is required.

2. A single submittal covering multiple Sections will not be accepted, unless the primary specification references other Sections for components: For example, if a pump Section references other Sections for the motor, shop-applied protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted, whereas a single submittal covering vertical turbine pumps and horizontal split-case pumps would not be accepted.

3. On the transmittal form, index the components of the submittal.

4. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, room number, or building name, as applicable.

5. Unless otherwise indicated, match terminology and equipment names and numbers used in the submittals with those used in the Contract Documents.

F. Format

1. Submittals shall be submitted as a PDF document.

2. Number every page in a submittal in sequence.

3. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports.

4. Present a sufficient level of detail for assessment of compliance with the Contract Documents.

5. Before accepting the number system option in the following Subparagraph, the Specifier should verify that the document tracking system to be used in the field office will function under an alphanumeric system. If not, select the second optional wording for compatibility.

6. Numbering

a. Assign to each submittal a unique number.

b. Number the submittals sequentially, with the submittal numbers clearly noted on the transmittal.

c. Assign original submittals a numeric submittal number followed by a decimal point and a numeric digit in order to distinguish between the original submittal and each resubmittal: For example, if submittal "25.1" requires a resubmittal, the first resubmittal will bear the designation "25.2" and the second resubmittal will bear the designation "25.3," and so on.

G. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

H. Engineer's Review

1. Except as otherwise indicated, the Engineer will return prints of each submittal to the Contractor with comments noted thereon, within 30 Days following receipt by the Engineer.

2. It is considered reasonable that the Contractor shall make a complete and acceptable submittal to the Engineer by the first resubmittal on an item.

3. The Owner reserves the right to withhold monies due to the Contractor to cover additional costs of the Engineer's review beyond the first resubmittal.

4. The Engineer's maximum review period for each submittal or resubmittal will be 30 Days; thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 120 Days.

I. If a submittal is returned to the Contractor marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

J. If a submittal is returned marked "MAKE CORRECTIONS NOTED," the Contractor shall make the corrections on the submittal, but formal revision and resubmission will not be required.

K. Resubmittals

1. If a submittal is returned marked "AMEND-RESUBMIT," the Contractor shall revise the submittal and resubmit the required number of copies.

2. Resubmittal of portions of multi-page or multi-drawing submittals will not be accepted: For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND-RESUBMIT," the submittal as a whole is deemed "AMEND-RESUBMIT," and 10 drawings are required to be resubmitted.

3. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

L. Rejected Submittals

1. If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 – Products, Materials, Equipment, and Substitutions.

M. The fabrication of an item may commence only after the Engineer has reviewed the pertinent submittals and returned copies to the Contractor marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

N. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

O. Review by Contractor

1. Submittals shall be carefully reviewed by an authorized representative of the Contractor prior to submission to the Engineer.

2. Each submittal shall be dated and signed by the Contractor as being correct and in strict conformance with the Contract Documents.

3. In the case of Shop Drawings, each sheet shall be so dated and signed.

4. Any deviations from the Contract Documents shall be noted on the transmittal sheet.

5. The Engineer will only review submittals that have been so verified by the Contractor.

6. Non-verified submittals will be returned to the Contractor without action taken by the Engineer, and any delays caused thereby shall be the total responsibility of the Contractor.

P. Conformance

1. Corrections or comments made on the Contractor's Shop Drawings during review shall not relieve the Contractor from compliance with Contract Drawings and Specifications.

2. A lack of comments made on the Contractor’s Shop Drawings during review shall not relieve the Contractor from compliance with Contract Drawings and Specifications.

3. Review is for conformance to the design concept and general compliance with the Contract Documents only.

4. The Contractor shall be responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating Work with the trades, and satisfactory and safe performance of the Work.

1.05 SAMPLES

A. Quantity

1. The Contractor shall submit the number of samples indicated by the Specifications.

2. If the number is not indicated, submit not less than 3 samples.

3. Where the quantity of each sample is not indicated, submit such quantity as necessary for proper examination and testing by the methods indicated.

B. Identification and Distribution

1. Individually and indelibly label or tag each sample, indicating the salient physical characteristics and the manufacturer's name.

2. Upon acceptance by the Engineer, one set of samples will be retained by the Engineer, and one set shall remain at the Site in the Engineer's field office until completion of the Work.

C. Selection

1. Unless otherwise indicated, the Engineer will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines.

2. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the Contractor shall clearly state so on the transmittal page of the submittal.

D. The Contractor shall schedule sample submittals such that:

1. Sample submittals for color and texture selection are complete so the Engineer has 45 Days to assemble color panels and select color- and texture-dependent products and materials without delay to the construction schedule; and,

2. After the Engineer selects colors and textures, the Contractor has sufficient time to provide the products or materials without delay to the construction schedule.

3. The Contract Times will not be extended for the Contractor's failure to allow enough review and approval or selection time, failure to submit complete samples requiring color or texture selection, or failure to submit complete or approvable samples.

1.06 TECHNICAL MANUAL

A. The Contractor shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.

B. The manual shall be written such that it can be used and understood by the Owner's operation and maintenance staff.

C. The Specifier must consider whether the organization of information in the manuals is appropriate for the scope of the Work. If possible during customization, discuss the manual organization with Owner staff and O&M manual specialists.

D. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

a. Category 1 - Equipment Summary

1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

2) Form: The Engineer will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the Work. The Contractor shall fill in the relevant information on the form and include it in Part 1.

b. Category 2 - Operational Procedures

1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

a) Installation

b) Adjustment

c) Startup

d) Location of controls, special tools, equipment required, or related instrumentation needed for operation

e) Operation procedures

f) Load changes

g) Calibration

h) Shutdown

i) Troubleshooting

j) Disassembly

k) Reassembly

l) Realignment

m) Testing to determine performance efficiency

n) Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices

o) List of all electrical relay settings including alarm and contact settings

c. Category 3 - Preventive Maintenance Procedures

1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

d. Category 4 - Parts List

1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

e. Category 5 - Wiring Diagrams

1) Diagrams: Category 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

f. Category 6 - Shop Drawings

1) Drawings: This category includes approved shop or fabrication drawings with Engineer comments and corrections incorporated, complete with dimensions.

g. Category 7 - Safety

1) Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Category 8 - Documentation:

1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

E. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, Owner's project number, Specification Section number, equipment name, and equipment identification number

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.

3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 by 11 shall be folded to 8-1/2 by 11 size.

4. Provide electronic files with each final set of Technical Manuals, as follows:

a. Project-specific files created in the latest version of Microsoft Word;

b. AutoCad, version, latest version;

c. Adobe Acrobat portable document format (PDF) or other software required by the Specifications; and,

d. Manufacturer literature in Adobe Acrobat portable document format (PDF).

F. Review Process

1. Furnish 3 draft Technical Manuals for each Specification Section that requires a manual.

2. The Engineer will retain one copy, will forward one copy to the Owner, and will return one copy to the Contractor with review comments.

3. Incorporate comments into the draft and submit 2 identical copies of the final manual for acceptance.

G. Schedule

H. The first alternative paragraph below is for a project with all new construction where interest in manuals increases as the day approaches when the Owner staff receives training on all the new equipment. The second paragraph is for rehabilitation projects or those with new equipment installed at multiple locations within an existing facility. In this case, Owner occupancy of new equipment can begin long before the end of construction. Retain one paragraph or the other, but not both.

I. Submittal and Corrections

1. The Work under this Contract involves start-up and commissioning of equipment in multiple areas of the facility at independent times within the Project Schedule.

2. The manuals shall be completed for each piece of equipment prior to final acceptance of the equipment by the Owner.

3. Except as otherwise indicated, submit the manuals for review in final form a minimum of 30 Days prior to the start of performance testing for each piece of equipment.

4. Discrepancies found by the Engineer shall be corrected within 30 Days from the Date of written notification by the Engineer.

J. Manuals that are incomplete or unacceptable at the schedule criterion above will constitute sufficient justification for the Owner to retain the amount in Paragraph "Technical Manual Submittals" of Section 01 77 00 – Project Closeout, from any monies due the Contractor.

K. If the parts list would be the same as the spare parts list on the Project, Paragraph 1.6A could be incorporated into Category 4 of the Technical Manual, above.

1.07 SPARE PARTS LIST

A. General

1. Furnish to the Engineer 3 identical sets of spare parts information for mechanical, electrical, and instrumentation equipment.

2. The spare parts list shall include those spare parts that each manufacturer recommends to be maintained by the Owner in inventory.

B. Sources and Pricing

1. The spare parts list shall include a current list price of each spare part.

2. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts, to assist the Owner in ordering.

C. Format

1. Cross-reference the spare parts lists to the equipment numbers designated in the Contract Documents.

2. The spare parts lists shall be

3. The binder ring size shall not exceed 2-1/2 inches.

4. Each copy of the spare parts lists shall be accompanied by an electronic version containing the lists in a PDF electronic format.

1.08 AS-BUILT DRAWINGS

A. On-Site Drawings Set

1. Maintain one set of Drawings at the Site for the preparation of as-built drawings.

2. On this set, mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction.

3. Give special attention to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.

4. Supplement the as-built drawings by any detailed sketches as necessary or as directed, in order to fully indicate the Work as actually constructed.

5. The as-built drawings are the Contractor's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the Work.

6. Use red font for alterations and notes.

7. Notes shall identify relevant Change Orders by number and date.

B. Submittal

1. Submit paper copies of the as-built drawings on the 20th Day of every third month after the month in which the Notice to Proceed is given, as well as at completion of the Work.

2. Failure to submit complete as-built drawings on or before the 20th Day will enact the liquidated damages clause for interim record drawing submittals described in Article 3 of the Agreement.

C. In the case of those drawings that depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, update the as-built drawings by indicating those portions which are superseded by Change Order drawings or final Shop Drawings, and by including appropriate reference information describing the Change Orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.

D. Unacceptable Drawings

1. Disorganized or incomplete as-built drawings will not be accepted.

2. The Contractor shall revise them and resubmit within 10 Days.

E. As-built drawings shall be accessible to the Engineer during the construction period.

F. Final Payment

1. Final payment will not be acted upon until the as-built drawings have been completed and delivered to the Engineer.

2. Up-to-date as-built drawings shall be in the form of a set of prints with carefully plotted information overlaid in AutoCad, latest version.

G. Information submitted by the Contractor will be assumed to be correct, and the Contractor shall be responsible for the accuracy of such information

1.09 QUALITY CONTROL (QC) SUBMITTALS

A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the Engineer that the Contractor has satisfied certain requirements of the Contract Documents.

B. Unless otherwise indicated, QC submittals shall be submitted:

1. Before delivery and unloading, for the following types of submittals:

a. Manufacturers' installation instructions

b. Manufacturers' and Installers' experience qualifications

c. Ready mix concrete delivery tickets

d. Design calculations

e. Affidavits and manufacturers' certification of compliance with indicated product requirements

f. Laboratory analysis results

g. Factory test reports

2. Within 30 Days of the event documented for the following types of submittals:

a. Manufacturers' field representative certification of proper installation

b. Field measurement

c. Field test reports

d. Receipt of permit

e. Receipt of regulatory approval

C. The Engineer will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

D. Retain the following article only if our CM forms will be used.

1.10 INFORMATIONAL SUBMITTALS

A. Informational submittals formalize the flow of information between the Contractor and the Engineer.

B. Electronic forms shall be obtained from the Engineer for such purpose.

C. The following forms may be used, but the list is not necessarily inclusive:

1. CM - 205 Allocation of Total Contract Price

2. CM - 302 Request for Clarification

3. CM - 306 Contractor’s Submittal Transmittal Form

4. CM - 307 Memorandum of Delay

5. CM - 432 System Outage Request

6. CM - 501 Request for Construction Staking

7. CM - 503 Request for Shutdown

8. CM - 1001 Monthly Payment Estimate Summary

9. CM - 1003 Request for Payment for Material on Hand

10. CM - 1004 Request for Adjustment of Retainage

11. CM - 1005 Consent of Surety for Reduction of Partial Release of Retainage

12. CM - 1006 Consent of Surety for Final Payment

13. CM - 1007 Affidavit of Payment

14. CM - 1101 Field Order

15. CM - 1102 Initiator Change Order Request

16. CM - 1106 Deviation Request

17. CM - 1110 Substitution Request Form

18. CM - 1202 Contractor's Certification of Completion

19. CM - 1301 Partial Waiver of Lien

20. CM - 1302 Final Waiver of Lien

D. CM - 1303 Affidavit of Release of Lien

1.11 CONSTRUCTION PHOTOGRAPHS

A. General

1. Furnish construction photographs showing the progress of the Work.

2. Provide electronic JPEG photos with the date of photographing, the project title, a short description of what is in the photograph, and the direction the camera is facing.

B. Prints and Negatives

1. Starting when the Work begins and continuing for as long as the Work is in progress, take not less than 12 images at intervals not more than 2 weeks apart, consisting of different subjects or angles or view at different locations of progress on the Site.

2. Furnish to the Engineer within 2 weeks after the date photos are taken.

3. The JPEG photos shall become sole property of the Owner upon submittal by the Contractor.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 17 – STRUCTURAL DESIGN, SUPPORT AND ANCHORAGE

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide calculations and details for structural and non-structural components, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The Contractor shall furnish and install all such structural and non-structural components, supports, and anchorages in accordance with the calculations and details.

B. The Contractor shall provide calculations and details for structures and non-building structures, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The Contractor shall furnish and install all such structures and non-building structures, supports, and anchorages in accordance with the calculations and details.

C. Where a conflict exists between the requirements of the Contract Documents and the 2021 IBC, the more stringent requirement shall apply.

D. Design parameters used to determine Seismic and Wind design forces shall be as listed herein.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
03 60 00	Grouting
05 50 00	Metal Fabrications
05 05 19	Post-Installed Concrete Anchors

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

IBC	2021 International Building Code
American Society of Civil Engineers (ASCE)	
ASCE 7 -16	Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
American Concrete Institute (ACI)	
ACI 318	Building Code Requirements for Structural Concrete (2019 edition)
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures and Commentary (2006 Edition)
The Masonry Society (TMS)	
TMS 402	Building Code for Masonry Structures (2016 edition)
TMS 602	Specification for Masonry Structures (2016 edition)

American Water Works Association (AWWA)	
AWWA D100	Welded Carbon Steel Tanks for Water Storage (2011 Edition)

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1. Calculations and Details

2. Calculations and details are considered a Deferred Submittal as defined in the IBC.

3. Calculations and details shall be complete, accurate, and in accordance with the requirements of the IBC and ASCE 7 and shall be signed and sealed by a Professional Engineer registered in the State of Washington.

4. Calculations shall be clear and concise and show equipment and other non-structural component anchorage forces and the capacities of the anchorage elements proposed by the Contractor. The calculations shall substantiate a complete load path from the component or equipment being anchored into the supporting structure or foundation.

5. The calculations and details shall demonstrate a complete lateral and vertical load path and shall clearly indicate all forces imposed on the supporting structure.

6. Calculations and details are required for all Non-Structural components, supports, anchorages, and attachments.

   a. Non-Structural components shall include all architectural, mechanical, and electrical components, equipment, piping, ductwork, and all other similar or related appurtenances necessary to produce the complete architectural, mechanical, and electrical systems.

7. When the Contract Documents require the Contractor to design structures or structural components, calculations and details for those structures and structural components, and their supports, anchorages, and attachments, are required.

8. When computer generated calculations and analyses are included as part (or as the whole) of the calculations, the calculations shall include, but not be limited to, the following: derivations of all input parameters; clear indication of the applicable load combinations and building code equations; diagrams of all members, geometry, loads, forces, reactions and deflections, for all components and connections; and output results demonstrating all stress, force, deflection and other Contract Document and building code requirements have been satisfied.

9. All calculations associated with anchorage into concrete or masonry shall be done using Strength Level forces and shall be in accordance with the applicable provisions of ACI 318 and TMS 402, respectively.

10. Refer to Part 2 below for additional requirements.

1.04 SEISMIC DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

    a. Risk Category: III.

    b. Seismic Design Category: D.

    c. Mapped MCE_R, 5% damped spectral response acceleration parameter at short periods: S_S = 0.592.

    d. Mapped MCE_R, 5% damped spectral response acceleration parameter at a period of 1-second: S_1 = 0.268.

    e. Site Class: D.

    f. Design, 5% damped spectral response acceleration parameter at short periods: S_{DS} = 0.613.

    g. Design, 5% damped spectral response acceleration parameter at a period of 1-second: S_{D1} = 0.685.

    h. Seismic response coefficient: Cs shall be calculated in accordance with ASCE 7-16, Supplement 3, Section 11.4.8.2, Exception 2.

    i. Long period transition period: T_L = 16 seconds

    j. Response modification coefficient, R: In accordance with ASCE 7, Tables 12.2-1, 12.14-1, 15.4-1 and 15.4-2.

    k. Seismic Importance Factor, I: 1.25.

    l. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

    m. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

For Risk Category III Structures, include the following Ip paragraph.

    n. Component importance factor, I_p:

    o. I_p = 1.00, unless noted otherwise herein.

        1) I_p = 1.50 if any of the following conditions apply:

            a) The component is required to function for life-safety purposes after an earthquake, including fire sprinkler systems and egress stairways.

            b) The component conveys, supports, or otherwise contains toxic, highly toxic, explosive, or hazardous substances.

2. The following components are exempted from the seismic design requirements:

    a. Exemptions shall be as indicated in ASCE 7 Chapter 13.

1.05 WIND DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

a. Risk Category: III.

b. Basic 3-second Wind Gust Speed: 104 miles per hour.

c. Exposure Category: C.

d. Topographic Factor, K_{zt}: 1.0.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Non-Structural Component Supports and Anchors

1. Unless otherwise indicated, non-structural component supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic and wind loads.

a. Wall-mounted equipment weighing more than 250 lbs or which is within 18-in of the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel or engineered framing support systems. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

b. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the building code and the Contract Documents.

c. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the manufacturer's applicable seismic certification requirements.

2. Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.

B. Non-Building Structures

1. Non-Building Structures shall be designed in accordance with ASCE 7 Chapter 15.

2. Non-Building Structures, foundations, supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic and wind loads.

3. Friction shall not be used to resist sliding due to seismic forces, except as indicated below:

a. Friction may be used to resist sliding of Welded or Bolted Steel Tanks designed in accordance with AWWA D100 or AWWA D103, respectively, when specifically permitted by that Standard.

C. Anchors – General

1. Anchor bolts shall be cast-in-place unless otherwise noted or approved by the Engineer.

2. Anchor bolts shall be in accordance with Section 05 50 00 – Metal Fabrication.

3. Adhesives and epoxies for post-installed anchors in concrete shall be in accordance with Section 05 05 19 – Post-Installed Concrete Anchors.

4. Grouts for anchor bolts shall be in accordance with Section 03 60 00 - Grouting.

5. The Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the calculations and details.

6. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all applicable load combinations, including seismic and wind loads.

    a. The design of anchors resisting seismic forces shall satisfy the ductility requirements stated in the IBC.

7. Reduction factors associated with edge distance, embed length, grout and base plate thickness, and bolt spacing shall all be considered and based on the actual dimensions of the concrete that resists the anchorage forces.

8. Where anchorage is required into or through equipment pads, the following requirements shall apply unless otherwise approved by the Engineer:

    a. For tensile forces, the embed length and associated concrete failure zone shall be provided entirely within the structural slab. No portion of the equipment pad may be considered as effective in resisting tensile forces.

    b. For shear forces, the edge distance and associated concrete failure zone shall be provided entirely within the equipment pad. No portion of the structural slab may be considered as effective in resisting shear forces.

9. Anchor bolt details shall include required bolt diameter, embed, spacing, and edge distances.

10. Where additional reinforcement is required to satisfy anchorage requirements, such reinforcement shall be included in the anchorage details, and shall be furnished and installed by the Contractor.

D. Mechanical and Electrical Equipment Foundations

1. Equipment foundations are indicated on Drawings. The Contractor, through the equipment manufacturer, shall verify the size and weight of the equipment foundation to ensure compatibility with equipment.

2. Equipment foundation dimensions shall be coordinated with the equipment base geometry and the edge distance and embed requirements of the equipment anchorage calculations.

E. Mechanical and Electrical Equipment (Housekeeping) Pads

1. General

a. Equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on concrete equipment pads, unless otherwise indicated. The top surface of the equipment pads shall be level, unless otherwise indicated, or otherwise required by the equipment manufacturer.

b. Equipment pads shall be sized to accommodate the bearing and anchorage requirements of the equipment, subject to the constraints listed below.

c. Final geometry of the equipment pads shall not result in a condition that violates applicable building code provisions, including but not limited to the provisions of the National Electric Code.

2. Mechanical Equipment Pads

a. Mechanical equipment pad heights shall be coordinated with process equipment and piping elevation requirements. Where no such elevation constraints exist, the equipment pad height shall be as shown on the drawings, or as indicated below when no specific height is provided.

1) Equipment pads for mechanical equipment shall be 3.5-in tall (maximum) at the front of the equipment.

b. Mechanical equipment pads shall extend not more than 2-in beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

1) Where necessary to meet seismic or wind anchorage requirements, the pads may be extended beyond the 2-in limit indicated above. The pads shall extend not more than 6-in beyond the front, back, and sides of the equipment.

3. Electrical Equipment Pads

a. Electrical equipment pads shall be 3.5-in tall (maximum) at the front of the equipment.

b. Electrical equipment pads shall extend not more than 2-in beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

c. Where necessary to meet seismic anchorage requirements, the pads may be extended beyond the 2-in limit indicated above. The pads shall extend not more than 6-in beyond the front, back, and sides of the equipment.

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 35 53 – SITE SECURITY

PART 1 -- GENERAL

1.01 SECURITY PROGRAM

A. The Contractor shall:

1. Protect Work, existing premises, and Owner's operations from theft, vandalism, and unauthorized entry.

2. Initiate program at mobilization.

3. Maintain program throughout construction period until Owner's occupancy of the new facility.

1.02 ENTRY CONTROL

A. The Contractor shall:

1. Restrict entry of persons and vehicles into Site and existing facilities.

2. Allow entry only to authorized persons with proper identification.

3. Maintain log of workmen and visitors and make log available to Owner on request.

B. The Contractor shall control the entrance of persons and vehicles to those related to the Owner's operations.

C. One gate may remain unlocked during work hours. All gates to remain locked outside of work hours.

D. The Contractor shall maintain a secure perimeter and replace any damaged or breached fencing or gates.

1.03 RESTRICTIONS

A. The Contractor shall not allow cameras on site or photographs taken except by written approval of Owner except for photo documentation as required by Section 01 33 00 – Submittal Procedures.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 13 – ABBREBIATIONS OF INSTITUTIONS

PART 1 -- GENERAL

1.01 GENERAL

A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of the Specifications, the following acronyms or abbreviations which may appear shall have the meanings indicated herein.

1.02 ABBREVIATIONS

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABMA	American Bearing Manufacturer's Association – ABMA
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AF&PA	American Forest and Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	The Asphalt Institute
AIA	American Institute of Architects
AIHA	American Industrial Hygiene Association
AIIM	Association for Information and Image Management
AIS	American Iron and Steel Requirement
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute

AITC	American Institute of Timber Construction
AMA	Acoustical Material Association
AMCA	Air Movement and Control Association International, Inc
ANS	American Nuclear Society
ANSI	American National Standards Institute, Inc.
APA	The Engineered Wood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
ASQ	American Society for Quality
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWCI	American Wire Cloth Institute
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BABA	Build American, Buy America
BBC	Basic Building Code, Building Officials and Code Administrators International
BHMA	Builders Hardware Manufacturer's Association

CABO	Council of American Building Officials
CDA	Copper Development Association
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLPCA	California Lathing and Plastering Contractors Association
CMAA	A division/section of the Material Handling Industry of America
CPG	Compressed Gas Association
CRSI	Concrete Reinforcing Steel Institute
DCDMA	Diamond Core Drilling Manufacturer's Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EI	Energy Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
ETL	Electrical Test Laboratories
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
FEMA	Federal Emergency Management Association
FHWA	Federal Highway Administration
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute, Hydraulic Institute
HSWA	Federal Hazardous and Solid Waste Amendments
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICBO	International Conference of Building Officials

ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
ICCEC	Electrical Code
ICEA	Insulated Cable Engineers Association
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code, Association Connecting Electronic Industries
IRC	International Residential Code
ISA	Instrument Society of Automation
ISDI	Insulated Steel Door Institute
ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
ITU-T	Telecommunications Standardization Sector of the International Telecommunications Union
LPI	Lightning Protection Institute
LRQA	Lloyd’s Register Quality Assurance
MBMA	Metal Building Manufacturer's Association
MIL	Military Standards (DoD)
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers

DASMA	Door and Access Systems Manufacturers Association International
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NCCLS	National Committee for Clinical Laboratory Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association or National Fluid Power Association
NISO	National Information Standards Organization
NIST	National Institute of Standards and Technology
NLGI	National Lubricating Grease Institute
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NWWDA	National Wood Window and Door Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PPI	Plastic Pipe Institute
RCRA	Resource Conservation and Recovery Act
RIS	Redwood Inspection Service, a division of the California Redwood Association, CRA
RMA	Rubber Manufacturers Association
RVIA	Recreational Vehicle Industry Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers

SDI	Steel Door Institute, Steel Deck Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricator's Association
SPIB	Southern Pine Inspection Bureau
SSBC	Southern Standard Building Code, Southern Building Code Congress
SSPC	Society for Protective Coating
SSPWC	Standard Specifications for Public Works Construction
STLE	Society of Tribologists and Lubricating Engineers
TAPPI	Technical Association of the Worldwide Pulp, Paper, and Converting Industry
TFI	The Fertilizer Institute
TIA	Telecommunications Industries Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
USDA	U.S. Department of Agriculture
USEPA	United States of America Environmental Protection Agency
WCLIB	West Coast Lumber Inspection Bureau
WDMA	National Window and Door Manufacturers Association
WEF	Water Environment Federation
WI	Woodwork Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19 – REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Titles of Sections and Paragraphs: Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.

B. Applicable Publications: Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.

C. Specialists, Assignments: In certain instances, specification text requires (or implies) that specific Work is to be assigned to specialists or expert entities who must be engaged to perform that Work. Such assignments shall be recognized as special requirements over which the Contractor has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of Work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The Contractor shall construct the Work in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.

B. Reference Standards

International Conference of Building Officials (ICBO)	
International Building Code of the International Code Council (ICC)	
National Electric Code (NEC)	
National Fire Protection Association (NFPA)	
Occupational Safety and Health Administration (OSHA)	
Title 29, Part 1926,	Construction Safety and Health Regulations, Code of Federal Regulations
Title 29, Part 1910,	Occupational Safety and Health Standards, Code of Federal Regulations
Standard Specifications for Public Works Construction (SSWPC)	

C. References to "Building Code" or International Building Code" shall mean International Building Code of the International Code Council (ICC) as amended by the local jurisdiction. References to "Mechanical Code" or "Uniform Mechanical Code," "Plumbing Code" or "Uniform Plumbing Code," "Fire Code" or "Uniform Fire Code," shall mean Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code of the International Association of Plumbing and Mechanical Officials (IAPMO) as amended by the local jurisdiction. "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of the codes as approved by the Municipal Code and used by the local agency as of the date that the Work is advertised for Bids shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

D. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and direction prior to ordering or providing any materials or furnishing labor. The Contractor shall bid for the most stringent requirements.

E. References to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

F. References to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. Applicable Standard Specifications: References in the Contract Documents to "Standard Specifications" or SSPWC shall mean the Standard Specifications for Public Works Construction.

1.03 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. The Contractor shall be responsible that all Work included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist and the Owner has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00 – CONTRACTOR QUALITY CONTROL

PART 1 -- GENERAL

1.01 DEFINITION

A. Specific quality control requirements for the Work are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the Work beyond furnishing of manufactured products. The term "Quality Control" includes inspection, sampling and testing, and associated requirements.

1.02 INSPECTION AT PLACE OF MANUFACTURE

A. Unless otherwise indicated, all products, materials, and equipment shall be subject to inspection by the Engineer at the place of manufacture.

B. The presence of the Engineer at the place of manufacturer, however, shall not relieve the Contractor of the responsibility for providing products, materials, and equipment which comply with all requirements of the Contract Documents. Compliance is a duty of the Contractor and said duty shall not be avoided by any act or omission on the part of the Engineer.

1.03 SAMPLING AND TESTING

A. Unless otherwise indicated, all sampling and testing will be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the Owner reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the Engineer will assure the Owner that the quality of the workmanship is in full accord with the Contract Documents.

B. Any waiver by the Owner of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the testing or other quality assurance requirements originally indicated, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial Work, shall not be construed as a waiver of any requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the Engineer reserves the right to make independent investigations and tests, and failure of any portion of the Work to meet any of the requirements of the Contract Documents, shall be reasonable cause for the Engineer to require the removal or correction and reconstruction of any such Work in accordance with the General Conditions.

1.04 INSPECTION AND TESTING SERVICE

A. Inspection and testing laboratory service shall comply with the following:

1. Unless indicated otherwise by the Technical Specifications, the Owner will appoint, employ, and pay for services of an independent firm to perform inspection and testing or will perform inspection and testing itself.

2. The Owner or independent firm will perform inspections, testings, and other services as required by the Engineer under Paragraph 1.3C above.

3. Reports of testing, regardless of whether the testing was the Owner's or the Contractor's responsibility, will be submitted to the Engineer , indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

4. The Contractor shall cooperate with the Owner or independent firm and furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.

5. The Contractor shall notify Engineer 24 hours prior to the expected time for operations requiring inspection and laboratory testing services.

6. Retesting required because of non-conformance to requirements shall be performed by the same independent firm on instructions by the Engineer. The Contractor shall bear all costs from such retesting.

7. For samples and tests required for Contractor's use, the Contractor shall make arrangements with an independent firm for payment and scheduling of testing. The cost of sampling and testing for the Contractor's use shall be the Contractor's responsibility.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Inspection: The Contractor shall inspect materials or equipment upon the arrival on the job site and immediately prior to installation and reject damaged and defective items.

B. Measurements: The Contractor shall verify measurements and dimensions of the Work, as an integral step of starting each installation.

C. Manufacturer's Instructions: Where installations include manufactured products, the Contractor shall comply with manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in Contract Documents.

END OF SECTION

SECTION 01 50 10 – PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.01 GENERAL

A. The Contractor shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation, all in accordance with the Contract Documents. Initial condition shall be based on condition shown in preconstruction photography and videos.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

32 90 00	Landscape Planting

1.03 RIGHTS-OF-WAY

A. The Contractor shall not do any Work that would affect any gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the Contractor enter upon the rights-of-way involved until notified that the Owner has secured authority from the proper party.

B. After authority has been obtained, the Contractor shall give said party due notice of its intention to begin work, if required by said party, and shall remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace the same.

1.04 PROTECTION OF SURVEY AND STREET OR ROADWAY MARKERS

A. The Contractor shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the Contractor shall be restored after street or roadway resurfacing has been completed.

1.05 RESTORATION OF PAVEMENT

A. General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner. Pavements which are subject to partial removal shall be neatly saw cut in straight lines.

B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction, the Contractor shall place temporary surfacing promptly after backfilling and shall maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, the Contractor shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.

D. Restoration of Sidewalks or Private Driveways: Wherever sidewalks or private roads have been removed for purposes of construction, the Contractor shall place suitable temporary sidewalks or roadways promptly after backfilling and shall maintain them in satisfactory condition for the period of time fixed by the authorities having jurisdiction over the affected portions. If no such period of time is so fixed, the Contractor shall maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

1.06 EXISTING UTILITIES AND IMPROVEMENTS

A. General: The Contractor shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Drawings. The Contractor shall take all possible precautions for the protection of unforeseen Utility lines to provide for uninterrupted service and to provide such special protection as may be necessary. Utilities and other improvements which are adjacent but not included within the limits of an excavation required for performance of the Work shall be protected, supported, and maintained by the Contractor at his expense.

B. Except where the Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the Work, the Contractor shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Contractor's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the Contractor shall so notify the Owner.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the Utility.

D. Utilities to be Moved: In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the Contractor, be notified by the Owner to move such property within 30 days. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the Owner 30 days in advance for the necessary measures to be taken to prevent interruption of service.

E. Utilities to be Removed: Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the Contractor shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the Engineer and the Owner of the facility. In cases of temporary removal or relocation, restoration to the former location shall be accomplished by the Contractor in a manner that will restore or replace the Utility or improvement to its former locations and to as good or better condition than found prior to removal.

F. Utilities that Do Not Require Removal or Moving:

1. Utilities which are adjacent to but not included within the limits of an excavation required for performance of the Work shall be protected, supported, and maintained by the Contractor at no additional cost to the Owner.

2. Utilities within the limits of the Work which can be supported and maintained in service and which do not require removal and rebuilding shall be thus supported by the Contractor at his expense, including cost of repair due to damage caused by the Contractor operations.

a. Supports for water and gas mains, sewers, conduits, and similar utilities shall be constructed of timber or other acceptable materials; shall be supported from undisturbed foundations and shall be sufficiently substantial to ensure protection against settlement when pipe trenches or other excavations are backfilled. In all cases where permits or inspection fees are required by utilities in connection with changes to or temporary support of their conduits, the Contractor shall secure such permits and pay all permit and inspection fees.

b. The Contractor shall assume full responsibility for maintaining all public service utilities in operation and shall support and protect or remove and rebuild them at his own expense. Such services shall not be interrupted without permission of the owner of the public service utilities.

G. Owner's Right of Access: The right is reserved to the Owner and to the owners of public utilities and franchises to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

H. Underground Utilities Indicated: Existing Utility lines that are indicated or the locations of which are made known to the Contractor prior to excavation and that are to be retained, and all Utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced by the Contractor, unless otherwise repaired by the owner of the damaged Utility. If the owner of the damaged facility performs its own repairs, the Contractor shall reimburse said owner for the costs of repair.

I. Underground Utilities Not Indicated: In the event that the Contractor damages existing Utility lines that are not indicated or the locations of which are not made known to the Contractor prior to excavation, a verbal report of such damage shall be made within 24 hours to the Owner and a written report thereof shall be made promptly thereafter. If the Owner is not immediately available, the Contractor shall notify the Utility owner of the damage. If directed by the Owner, repairs shall be made by the Contractor under the provisions for changes and extra Work contained in Articles 10, 11, and 12 of the General Conditions.

J. Costs of locating and repairing damage and removing or relocating such Utility facilities not indicated in the Contract Documents, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such Utility facilities, and which was necessarily idled during such work will be paid for as extra work in accordance with the provisions of Articles 10, 11, and 12 of the General Conditions.

K. Approval of Repairs: All repairs to a damaged Utility or improvement are subject to inspection and approval by an authorized representative of the Utility or improvement owner before being concealed by backfill or other work.

L. Maintaining in Service: Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Owner are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. The Contractor shall be responsible for and shall repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

1.07 TREES OR SHRUBS WITHIN PROJECT LIMITS

A. General: Except where trees or shrubs are indicated to be removed, the Contractor shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or owner. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by a certified tree specialist under permit from the jurisdictional agency and/or the Owner and paid for by the Contractor. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

B. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1 1/2 inches (38 mm) in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement: The Contractor shall immediately notify the jurisdictional agency and the Owner if any tree or shrub is damaged by the Contractor's operations. If, the jurisdictional agency or the Owner's licensed arborist, determines that the damage is such that replacement is necessary, the Contractor shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, the Contractor shall pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or owner. The size of the tree or shrub shall be not less than 1 inch (25 mm) diameter nor less than 6 feet (1.8 m) in height. Planting of replacement trees and shrubs shall be in accordance with Section 32 90 00 – Planting. Unless otherwise indicated, the Contractor shall water and maintain the replacement trees and shrubs for 6 months after planting.

1.08 LAWN AREAS

A. Lawn or landscaped areas damaged during construction shall be repaired to match the pre-construction condition as indicated by the preconstruction photographs and videos.

1.09 PROTECTION OF STREAMS AND WATERWAYS

A. Stream or waterway bank trees, shrubs, and other vegetation should be left in place to help control erosion; where equipment operation requires tree removal, stumps and roots are to remain in place to help anchor the stream bank. Clearing of the stream or waterway banks should be avoided until immediately proceeding construction.

B. Prior to the onset of any stream or waterway crossing, silt barriers shall be placed along the banks where vegetation removal has occurred or is anticipated, exposed soil exists, and/or spoils or other fill materials are to be stockpiled within 50 feet (15 m) of the stream or waterway.

C. Construction within a stream or waterway will be continued until completed. A stream or waterway crossing shall not be initiated unless the Contractor is prepared to finish the work immediately. Also, work must not be initiated unless time and weather constraints have been provided for. Stream or waterway crossing work shall be restricted to periods of dry weather and low-flow conditions.

D. Backfill should be placed to extend the full width of the trench and the full length of the stream or waterway crossing as called for on the drawings. The balance of the trench should be filled so as to conform to the existing stream or waterway bed and banks.

E. Restoration should include the re-establishment of channel contours and bank stabilization and should be initiated immediately after the crossing is completed. Limit the use of rip-rap or similar stabilization techniques to areas where stream or waterway flow conditions prevent vegetative stabilization.

F. The width of the easement for the stream or waterway crossing should be restricted to only that necessary to perform the work.

G. Construction materials, supplies, equipment, excavated materials, construction debris, and any other work-related items should be stored, placed and/or operated so as to minimize interference with normal stream or waterway flow and shall be kept out of the stream or waterway channel except during actual pipe installation.

1.10 PROTECTION OF ARCHAEOLOGICAL/HISTORICAL RESOURCES

A. If, during the course of construction, evidence of deposits of historical and/or archaeological interest is found, the Contractor and subcontractors are required under the Washington Department of Archaeology + Historic Preservation. Upon discovery, the Contractor will cease operations and no further disturbance of the area will occur until an official from regulating agency has surveyed the find, made a determination of the value of the find and effect of continued construction disturbances, and submitted the results of the determination to the Owner.

Contact:	DAHP
Address:	1110 S. Capital Way, Suite 30
	Olympia, WA 98501
Phone number:	360 586 3065

1.11 NOTIFICATION BY THE CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than 3 business days nor more than 7 business days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire. The Contractor shall also notify DigSafe.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 51 00 – TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 SUMMARY

A. The types of utility services required for general temporary use at the Site include but are not limited to the following:

1. Water service (potable for certain uses)
2. Storm sewer
3. Sanitary sewer
4. Electric power service
5. Telephone service
6. Gas service
7. Heating and cooling

B. The Contractor shall provide the specified temporary utilities required in order to execute the Work expeditiously. Remove the temporary utilities from the Site upon completion of the Work unless specified otherwise.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 52 00	Field Offices, Equipment, and Services

1.03 JOB CONDITIONS

A. Scheduled Uses: The Contractor, in conjunction with establishing the progress schedule, shall establish a schedule for implementation and termination of service for each temporary utility at the earliest feasible time, and when approved by the Owner, change over from temporary utility service to permanent service.

1.04 PERMITTING

A. The Contractor shall make necessary applications to authorities having jurisdiction, obtain required permits, and pay all fees and related charges.

1.05 TEMPORARY USE OF OWNER'S FACILITIES

A. Permanent systems shall not be used without the written permission of the Owner.

B. If written permission is obtained to use existing heating systems or other systems temporarily before completion, entirely change lubricants, filters and other accessory items upon completion of the Work. Extend warranties to ensure that The Owner receives coverage for the full warranty period, as specified.

C. Temporary or trial usage of any mechanical machinery, apparatus, equipment or any other work or materials by The Owner supplied under the Work before final acceptance by the Owner is not to be construed as evidence of acceptance. The Owner shall have the privilege of such temporary and trial usage as soon as the Contractor claims that the Work is complete.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide either new or used materials and equipment, that are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by utility company, the Contractor shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations of the utility company.

PART 3 -- EXECUTION

3.01 INSTALLATION OF TEMPORARY UTILITY SERVICES

A. General: Wherever feasible, the Contractor shall engage the utility company to install temporary service to the Site, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with Work, including installation of permanent utility services; and maintain temporary services as installed for required period of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate the Work.

B. The Contractor shall pay all costs for installation, maintenance, consumption, and removal of temporary utilities.

C. Approval of Electrical Connections: Temporary connections for electricity shall be subject to approval of the power company representative and shall be removed in like manner at the Contractor's expense prior to final acceptance of the Work.

D. Separation of Circuits: Circuits used for power purposes shall be separate from lighting circuits.

E. Construction Wiring: Wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. Electrical facilities shall conform to the requirements of Subpart K of the OSHA Safety and Health Standards for Construction.

3.02 INSTALLATION OF POWER DISTRIBUTION SYSTEM

A. Power: The Contractor shall provide power required for its operations under the Contract and shall provide and maintain temporary power lines required to perform the Work in a safe and satisfactory manner. The Contractor shall arrange with the utility company to extend electric service to the Project Work Site, connect temporary service in a manner directed by the utility company officials, and provide separate meter for metering of power used by all entities authorized to be at or perform Work at the Project Work Site.

B. Temporary Power Distribution: The Contractor shall provide a weatherproof, grounded, temporary power distribution system sufficient for performance of the entire Work, including temporary electrical heating where indicated, operation of test equipment and test operation of building equipment and systems which cannot be delayed until permanent power connections are operable, temporary operation of other temporary facilities, including permanent equipment and systems which must be placed in operation prior to use of permanent power connections (pumps, HVAC equipment, elevators, and similar equipment), and power for temporary operation of existing facilities (if any) at the Site during change-over to new permanent power system. Provide circuits of adequate size and proper power characteristics for each use; run circuit wiring generally overhead, and rise vertically in locations where it will be least exposed to possible damage from construction operations and will result in minimal interference with performance of the Work; provide rigid steel conduit or equivalent raceways for wiring which must be exposed on grade, floors, decks, or other exposures to damage or abuse.

3.03 INSTALLATION OF LIGHTING

A. Construction Lighting: Work conducted at night or under conditions of deficient daylight shall be suitably lighted in accordance with local lighting ordinances and to afford adequate facilities for inspection and safe working conditions. Lighting shall be provided and maintained adequately to safely perform the Work. Contractor shall provide a general, weatherproof, grounded temporary lighting system in every area of construction as soon as overhead floor/roof deck structure has been installed to provide sufficient illumination for safe working and traffic conditions. Run circuit wiring generally overhead and rise vertically in locations where it will be least exposed to possible damage from construction operations on grade, floors, decks, or other areas of possible damage or abuse.

B. Light pollution off the Site shall be avoided and the construction lighting impact off the Site shall be addressed in the Construction Management plan in accordance with the local lighting ordinance.

3.04 WATER SUPPLY

A. The Contractor shall provide facilities necessary to convey the water from the source to the points of use such as reduced pressure backflow preventers, hydrant meters, and NSF 61 piping in accordance with the requirements of the Contract Documents. Water capacity charges and the wet tap fees will be paid by the Owner. The Contractor shall pay the fee for water meter and other charges for water use.

B. General: The Contractor shall provide an adequate supply of water of a quality suitable for all domestic and construction purposes.

C. Water Connections: The Contractor shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, the Contractor shall first attach to the fire hydrant or pipeline a reduced pressure backflow preventer, valve and meter, of a size and type acceptable to said authority and agency. The Contractor shall pay permit and water charges.

D. The Contractor shall comply with disinfection and testing requirements as if the temporary water supply system was a permanent system.

3.05 INSTALLATION OF SANITARY FACILITIES

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of Contractor's employees and visitors. Toilets at construction sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction. Provide separate field office facilities in conformance with Section 01 52 00 – Field Offices, Equipment, and Services.

B. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in accordance with laws and regulations pertaining thereto.

C. Contractor shall provide toileting consumables and maintain sanitation facilities in a clean condition for the duration of the Work.

3.06 INSTALLATION OF FIRE PROTECTION

A. Fire Protection: The construction plant and the Work shall be connected with the Contractor's temporary water supply system and shall be adequately protected against damage by fire. Hose connections and hose, water casks, chemical equipment, or other sufficient means shall be provided for fighting fires in the temporary structures and other portions of the Work, and responsible persons shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The Contractor's fire protection program shall conform to the requirements of Subpart F of the OSHA Standards for Construction.

3.07 INSTALLATION OF HEATING AND COOLING

A. Temporary Heating and Cooling: Provide temporary heating and cooling system required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

B. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

C. Temporary heating and cooling systems shall be paid for by the Contractor.

3.08 OPERATIONS AND TERMINATIONS

A. Inspections: Prior to placing temporary utility services into use, the Contractor shall inspect and test each service and arrange for governing authorities' required inspection and tests and obtain required certifications and permits for use thereof.

B. Protection: The Contractor shall maintain distinct markers for underground lines and protect from damage during excavating operations.

C. Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, the Contractor shall promptly remove installation unless requested by the Owner to retain it for a longer period. The Contractor shall complete and restore Work which may have been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.

D. Removal of Water Connections: Before final acceptance of the Work on the project, temporary connections and piping installed by the Contractor shall be entirely removed and affected improvements shall be restored to original condition in accordance with the preconstruction video and photographs, to the satisfaction of the Owner and to the agency owning the affected utility.

END OF SECTION

SECTION 01 52 00 – FIELD OFFICE, EQUIPMENT, AND SERVICES

PART 1 -- GENERAL

1.01 SUMMARY

A. This section includes requirements of field offices for the resident project representative and/ or other representatives of the Owner

B. The Contractor shall provide field offices and equipment and furnish related services at the Site.

C. The office shall be located close to Contractor's field office, at a location designated by the Owner or as shown on the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 71 13	Mobilization
01 33 00	Submittal Procedures
01 51 00	Temporary Utilities
01 10 00	Summary of Work
01 45 00	Contractor Quality Control
01 29 73	Schedule of Values
01 35 53	Site Security

1.03 FIELD OFFICE SCHEDULE

A. Field offices, equipped as indicated herein, shall be provided at the Site, ready for exclusive use by the Owner and the Owner's representative within 14 Days after the commencement date stated in the Notice to Proceed. The Contractor's attention is directed to the condition that no payment for that portion of the Contract Price designated for mobilization, or any part thereof, will be approved for payment until the field office facilities indicated herein have been provided. The provisions for such payment are included in Section 01 71 13 - Mobilization.

B. Unless released earlier by the Owner in writing, field office(s) shall be maintained in full operation at the Site with all utilities connected and operable until the Notice of Completion has been executed or recorded. Upon execution or recordation of the Notice of Completion, or upon early release of the field office by the Owner, the Contractor shall remove the field office within 14 Days from said date and shall restore the Site occupied by the field office to the condition indicated.

PART 2 -- PRODUCTS

2.01 OFFICE FACILITIES

A. General: The Contractor shall provide necessary electrical wiring, plumbing, toilet and lavatory fixtures, air conditioning and heating equipment, and shelving, and shall furnish light, heat, water, and janitorial services in connection with the field office. Adequate all weather access, drives, parking areas, and walks shall also be provided.

B. Primary Field Office: The office shall be one separate, well lighted, air conditioned, electrically-heated field office with an ADA compliant toilet room containing a water closet and lavatory partitioned off from the working area. The water closet may be of the chemical type provided that it is a flush type with an approved holding tank. The toilet room door shall be provided with a latch set. The office shall have an outside door lock. Area of the field office shall not be less than 500 sq ft, including the toilet room area. Office shall be of the portable trailer type unless otherwise specifically authorized by the Owner in writing and shall be a separate unit, not attached or connected to any other structures. The office shall have as minimum one conference room, and one common area that can accommodate at least 2 desks. The floor plan shall be submitted to and approved by the Owner.

2.02 FIELD OFFICE FURNISHINGS

A. The Contractor shall furnish the following items in good condition in the primary field office:

B. Provide the following moveable items”

1. 3 office chairs.

2. 1 waste baskets.

3. 1 table 40-in by 96-in.

4. 1 10 lb Class ABC fire extinguisher.

5. 1 first aid kit, containing adhesive strips, gauze pads, triangular bandages, roll adhesive tape, antiseptic wipes, latex examination gloves, scissors, forceps, eye flush, cold pack, burn ointment, sting relief wipes and ibuprofen tablets.

6. 1 3 cu. ft self-defrosting refrigerator with freezer compartment.

7. 1 counter-top size microwave oven, 1 cu. ft minimum.

8. Potable drinking water and water cooler.

9. Furnish, for the duration of the project, a reliable broadband Internet connection (Digital Subscriber Line speed or better).

2.03 FIELD OFFICE SERVICES

A. Each field office shall be provided with sufficient lighting to produce not less than 50 foot-candles at desktop height at each desk location. Exterior lighting shall be provided over the entrance door.

B. Heating and air conditioning shall be provided throughout all rooms in the trailer.

C. A minimum of 4 110 VAC duplex grounded electric convenience outlets shall be provided in each office and in the conference room and common area. At least one such outlet shall be located on each wall. The electric distribution panel shall service not less than 2 110 VAC circuits.

D. Sanitary waste material shall be regularly pumped out and the chemicals recharged. Toilet paper and paper towels shall be furnished for each toilet facility.

E. Janitorial services shall be furnished during working hours every other day. Offices shall be swept, dusted, and waste receptacles emptied. Toilet facilities shall be sanitized and cleaned, and paper supplies shall be replenished.

PART 3 -- EXECUTION

3.01 SERVICES

A. All fuel, electricity, and internet service shall be paid by the Contractor.

B. The Contractor shall provide maintenance and cleaning once a week for the duration of the project. For a toilet or lavatory, these services shall include, but not limited to, paper towels, toilet paper, and soap.

C. The field office shall be maintained by the Contractor until the work is complete. Earlier removal shall not be done without prior written approval of the Owner. Field office removal and restoration shall be the Contractor’s responsibility.

3.02 SECURITY

A. The Contractor shall be responsible for the security of the field office trailer.

B. The Contractor shall comply with all security requirements specified in Section 01 35 53 – Site Security.

C. The Contractor shall supply Owner 2 sets of door keys for the field office and any other measured used to secure the trailer site.

3.03 LOCATION

A. Field office shall be located to provide access by the Owner and visitors without having to traverse site.

B. Field office shall be located where it will cause as little interference with the work as possible. Relocation of the field office during the course of the project shall be permitted upon written approval of the Owner.

C. Field office location shall be coordinated with and approved by the Owner.

END OF SECTION

SECTION 01 55 00 – SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.01 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards

American National Standards Institute (ANSI)	
ANSI D6.1	Manual on Uniform Traffic Control Devices for Streets and Highways

1.02 HIGHWAY LIMITATIONS

A. The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. It shall be the Contractor's responsibility to construct and maintain any haul roads required for its construction operations.

1.03 TEMPORARY CROSSINGS

A. General: Continuous, unobstructed, safe, and adequate pedestrian and vehicular access shall be provided to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300-feet shall be provided. The Contractor shall cooperate with parties involved in the delivery of mail and removal of trash and garbage so as to maintain existing schedules for such services. Vehicular access to residential driveways shall be maintained to the property line except when necessary, construction precludes such access for reasonable periods of time.

B. Temporary Bridges: Wherever necessary, to maintain vehicular crossings, the Contractor shall provide suitable temporary bridges or steel plates over unfilled excavations, except in such cases as the Contractor shall secure the written consent of the responsible individuals or authorities to omit such temporary bridges or steel plates, which written consent shall be delivered to the Engineer prior to excavation. Such bridges or steel plates shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the Contractor shall adopt designs furnished by said authority for such bridges or steel plates, or shall submit designs to said authority for approval, as may be required.

C. Street Use: Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder, and it shall conduct its operations to not interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of the Engineer and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise indicated. Toe boards shall be provided to retain excavated material if required by the Engineer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment. Temporary provisions shall be made by the Contractor to assure the use of sidewalks and the proper functioning of gutters, storm drain inlets, and other drainage facilities.

D. Traffic Control: For the protection of traffic in public or private streets and ways, the Contractor shall provide, place, and maintain necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the Manual of Uniform Traffic Control Devices, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1).

1. The Contractor shall take necessary precautions for the protection of the Work and the safety of the public. Barricades and obstructions shall be illuminated at night, and lights shall be kept burning from sunset until sunrise. The Contractor shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. Signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.

2. The Contractor shall submit 3 copies of a traffic control plan to the Authority Having Jurisdiction (AHJ) for approval a minimum of 2 weeks prior to construction. The AHJ shall be allowed access to observe these traffic control plans in use and to make any changes as field conditions warrant. Any changes required by the AHJ shall supersede these plans and be done solely at the Contractor's expense.

3. The Contractor shall remove traffic control devices when no longer needed, repair damage caused by installation of the devices, and shall remove post settings and backfill the resulting holes to match grade.

E. Temporary Street Closure: If closure of any street is required during construction, the Contractor shall apply in writing to the AHJ at least 30 Days in advance of the required closure. A Detour and Traffic Control Plan shall accompany the application.

F. Temporary Driveway Closure: The Contractor shall notify the owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one 8 hour work day at least 3 working days prior to the closure. The Contractor shall minimize the inconvenience and minimize the time period that the driveways will be closed. The Contractor shall fully explain to the owner/occupant how long the closure will take and when closure will start.

1.04 CONTRACTOR'S WORK AND STORAGE AREA

A. The Owner will designate and arrange for the Contractor's use, a portion of the property adjacent to the Work for its exclusive use during the term of the Contract as a storage and shop area for its construction operations on the Work. At completion of Work, the Contractor shall return this area to its original condition, including grading and landscaping.

B. The Contractor shall make its own arrangements for any necessary off-Site storage or shop areas necessary for the proper execution of the Work.

1.05 PARKING

A. The Contractor shall:

1. Provide temporary parking areas as follows:

a. 2 spaces for the Owner

b. 2 spaces for the Engineer or Construction Manager

2. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. The Contractor shall repair breaks, potholes, low areas which collect standing water, and other deficiencies.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

01 57 19 TEMPOSECTION 01 57 19 – TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.01 DUST ABATEMENT

A. The Contractor shall prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity of the Site. The Contractor shall be responsible for any damage resulting from dust originating from its operations. Dust abatement measures shall be continued until the Contractor is relieved of further responsibility by the Engineer.

B. Storage Piles: Enclose, cover, water (as needed), or apply non-toxic soil binders according to manufacturer's specifications on material piles (i.e. gravel, sand, dirt) with a silt content of 5 percent or greater.

C. Active Areas of Site: Water active construction areas and unpaved roads as needed and as requested by Engineer.

D. Inactive Areas of Site: Apply non-toxic soil stabilizers according to manufacturer's specifications to inactive construction areas, or water as needed to maintain adequate dust control.

E. Vehicle Loads: Cover or maintain at least 2-feet of freeboard vertical distance between the top of the load and the top of the trailer sides on trucks hauling dirt, sand, soil, or other loose materials off of the Site.

F. Roads: When there is visible track-out onto a paved public road, install wheel washers where the vehicles exit and enter onto the paved roads and wash the undercarriage of trucks and any equipment leaving the Site on each trip. Sweep the paved street at the end of each shift with mobile water spray pick-up broom-type street sweeper as necessary or as directed.

G. Vehicle Speeds: If watering of unpaved roads is not sufficient to control dust, reduce vehicle speeds to 15 mph or less on such roads.

1.02 SEDIMENTATION ABATEMENT

A. The Contractor shall be responsible for collecting, storing, hauling, and disposing of spoil, silt, and waste materials in compliance with applicable federal, state, and local rules and regulations and the Contract Documents.

B. Install and maintain erosion and sediment control measures, such as swales, grade stabilization structures, berms, dikes, waterways, filter fabric fences, and sediment basins.

C. Filter fabric barrier systems, if used, shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

D. Remove and dispose of sediment deposits at the designated spoil area. If a spoil area is not indicated, dispose of sediment off-Site at a location not in or adjacent to a stream or floodplain. Sediment to be placed at the spoil area should be spread evenly, compacted, and stabilized. Sediment shall not be allowed to flush into a stream or drainage way.

E. Maintain erosion and sediment control measures until final acceptance or until requested by the Engineer to remove it.

1.03 STORMWATER POLLUTION PREVENTION

A. Contractor shall minimize stormwater pollution from the Site in accordance with the Erosion Control found in the drawings, approved Stormwater Pollution Prevention Plan and Construction Stormwater General Permit

1.04 RUBBISH CONTROL

A. During the progress of the Work, the Contractor shall keep the Site and other areas for which it is responsible in a neat and clean condition and free from any accumulation of rubbish. The Contractor shall dispose of rubbish and waste materials of any nature and shall establish regular intervals of collection and disposal of such materials and waste. The Contractor shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal and in conformance with applicable safety laws and the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

1.05 SANITATION

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in a manner satisfactory to the Engineer and in accordance with Laws and Regulations pertaining thereto.

1.06 CHEMICALS

A. Chemicals used on the Work or furnished for facility operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in Article 6 of the General Conditions.

1.07 CULTURAL RESOURCES

A. The Contractor's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").

B. In the event potential cultural resources are discovered during subsurface excavations at the Site, the following procedures shall be instituted:

1. The Owner will issue a temporary Notice to Suspend Work directing the Contractor to cease construction operations at the location of such potential cultural resources find.

2. The suspension Notice will contain the following:

a. A clear description of the Work to be suspended

b. Instructions regarding issuance of further orders by the Contractor for material services

c. Guidance as to the action to be taken on subcontracts

d. Suggestions to the Contractor to minimize incurred costs

e. Estimated duration of the temporary suspension.

3. Such suspension shall be effective until such time as a qualified archeologist can assess the value of the potential cultural resources and make recommendations to the Department of Archaeology & Historic Preservation (DAHP).

4. The Owner will implement appropriate actions as directed by DAHP or the Project Manager. The Contractor shall cease Work in the area of a discovery until appropriate actions have been determined in accordance with this paragraph.

5. If human remains are discovered, Work in the immediate vicinity of the find shall stop. The County Coroner shall be notified.

C. If the archeologist determines that the potential find is a bonafide cultural resource, at the direction of DAHP, the Owner will extend the duration of the suspension.

D. Changes to the Contract Price and Contract Times for suspension due to discovery of a potential cultural resource will be made in the following manner:

1. Contract Times

a. If the Work temporarily suspended is on the “critical path”, the total number of Days for which the suspension is in effect will be added to the Contract Times.

b. If a portion of Work at the time of such suspension is not on the “critical path”, but subsequently becomes Work on the critical path, the Contract Times will be computed from the date such Work is classified as on the critical path.

2. Contract Price

   a. If, as a result of a cultural resources suspension, the Contractor sustains a loss that could not have been avoided by judicious handling of forces and equipment or redirection of forces or equipment to perform other Work on the contract, there will be paid an amount based on time and materials for the loss in accordance with the following:

      1) Idle Time of Equipment: Compensation for equipment idle time will be determined in accordance with the General Conditions for equipment time and equipment rental time.

      2) Idle Time of Labor: Compensation for idle time of workers will be determined in accordance with the General Conditions for labor.

   b. Costs of labor will be compensated only to the extent such cost was in fact caused by the suspension.

   c. Compensation for loss due to idle time of either equipment or labor will not include markup for profit.

   d. The hours for which compensation will be paid will be the actual normal working time during which such suspension lasts but will in no case exceed eight hours in any single Day.

   e. The days for which compensation will be paid exclude Saturdays, Sundays, and legal holidays during the suspension.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 58 13 – PROJECT SIGNAGE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide and install one project identification sign, complete, in accordance with the Contract Documents.

B. The Owner will obtain a sign permit, if one is required, at no cost to the Contractor.

PART 2 -- PRODUCTS

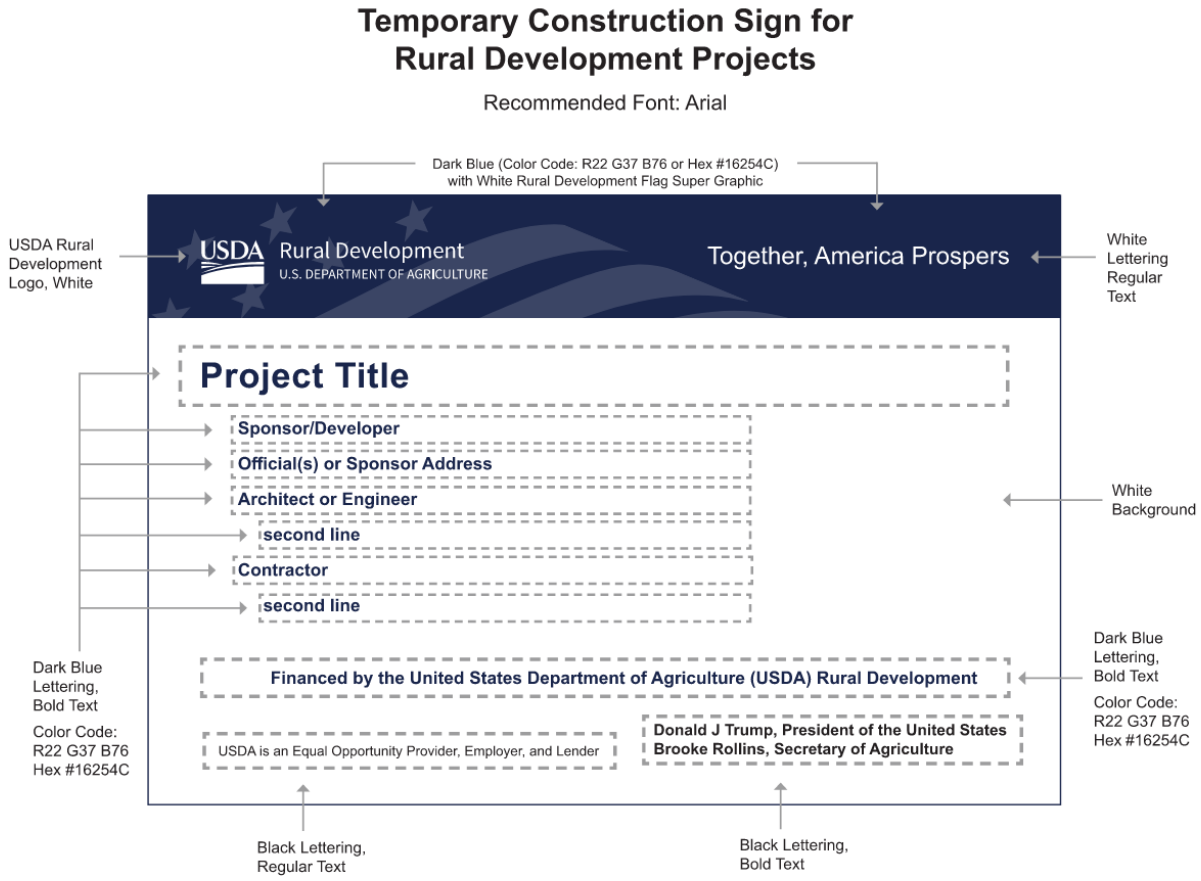
2.01 SIGN CONSTRUCTION

A. The sign shall be constructed of 3/4-inch plywood with 4-inch by 4-inch supports and 2-inch by 4-inch cross bracing.

B. The sign face shall be 4-feet vertical by 8-feet horizontal.

SIGN CONTENT

C. Sign content shall be:



SIGN DIMENSIONS: 1200mm x 2400mm x 19mm (approx.4' x 8' x 3/4)
PLYWOOD PANEL (APA RATED A+B GRADE-EXTERIOR)

PART 3 -- EXECUTION

3.01 SIGN LOCATION

A. The project sign shall be located on the Site as directed by the Owner.

B. The sign shall be set 4-feet above the ground, measured from grade to the lower edge of the plywood sheet.

3.02 REMOVAL

A. Remove the project sign upon preparation of the Notice of Completion.

END OF SECTION

SECTION 01 60 00 – PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS

PART 1 -- GENERAL

1.01 DEFINITIONS

A. The word "Products," as used in the Contract Documents, is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for the project or taken from Contractor's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form Work. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

B. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the Work.

1.02 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of Work, the Contractor shall provide products, materials, and equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for Contractor's selection of a product, material, or equipment, the Contractor shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

1.03 PRODUCT DELIVERY AND STORAGE

A. The Contractor shall deliver and store the Work in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the Contractor shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

1.04 TRANSPORTATION AND HANDLING

A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

B. The Contractor shall provide equipment and personnel to handle products, materials, and equipment [including those furnished by Owner,] by methods to prevent soiling and damage.

C. The Contractor shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.05 STORAGE AND PROTECTION

A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.

B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.

C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.

D. Storage shall be arranged to provide access for inspection. The Contractor shall periodically inspect to assure products are undamaged and are maintained under required conditions.

E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.06 MAINTENANCE OF PRODUCTS IN STORAGE

A. Stored products shall be periodically inspected on a scheduled basis. The Contractor shall maintain a log of inspections and shall make the log available on request.

B. The Contractor shall comply with manufacturer's product storage requirements and recommendations.

C. The Contractor shall maintain manufacturer-required environmental conditions continuously.

D. The Contractor shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.

E. For mechanical and electrical equipment, the Contractor shall provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.

F. Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the Owner in accordance with the Contract Documents.

1.07 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEM

A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other manufacturers may be accepted if sufficient information is submitted by the Contractor to allow the Engineer to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:

1. The burden of proof as to the type, function, and quality of any such substitution product, material or equipment shall be upon the Contractor. The Contractor shall provide the Owner with an agreed upon credit prior to evaluation of an “or equal” item.

2. The Engineer will be the sole judge as to the type, function, and quality of any such substitution and the Engineer's decision shall be final.

3. The Engineer may require the Contractor to furnish additional data about the proposed substitution.

4. The Owner may require the Contractor to furnish a special performance guarantee or other surety with respect to any substitution.

5. Acceptance by the Engineer of a substitution item proposed by the Contractor shall not relieve the Contractor of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.

6. The Contractor shall pay all costs, of implementing accepted substitutions (See Section 46 61 34 for additional requirements on alternate membrane system design responsibilities), including redesign and changes to Work necessary to accommodate the substitution. If the Engineer is required to provide redesign, payment shall be agreed upon prior to redesign efforts.

B. The procedure for review by the Engineer will include the following:

1. If the Contractor wishes to provide a substitution item, the Contractor shall make written application to the Engineer on the "Substitution Request Form."

2. Unless otherwise provided by law or authorized in writing by the Engineer, the "Substitution Request Form(s)" shall be submitted within the 35-day period after award of the Contract.

3. Wherever a proposed substitution item has not been submitted within said 35-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the Engineer, the Contractor shall provide the material or equipment indicated in the Contract Documents.

4. The Contractor shall certify by signing the form that the list of paragraphs on the form are correct for the proposed substitution.

5. The Engineer will evaluate each proposed substitution within a reasonable period of time.

6. As applicable, no shop drawing submittals shall be made for a substitution item nor shall any substitution item be ordered, installed, or utilized without the Engineer's prior written acceptance of the Contractor's "Substitution Request Form."

7. The Engineer will record the time required by the Engineer in evaluating substitutions proposed by the Contractor and in making changes by the Contractor in the Contract Documents occasioned thereby.

C. The Contractor's application shall address the following factors which will be considered by the Engineer in evaluating the proposed substitution:

1. Whether the evaluation and acceptance of the proposed substitution will prejudice the Contractor's achievement of Substantial Completion on time.

2. Whether acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitution.

3. Whether incorporation or use of the substitution in connection with the Work is subject to payment of any license fee or royalty.

4. Whether all variations of the proposed substitution from the items originally specified are identified.

5. Whether available maintenance, repair, and replacement service are indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

6. Whether an itemized estimate is included of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.

7. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.

D. Without any increase in cost to the Owner, the Contractor shall be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the Contractor's purchase thereof for incorporation in the Work, whether or not the Engineer accepts the proposed substitution or proposed equipment or material. The Contractor shall reimburse the Owner for the charges of the Engineer for evaluating each proposed substitution.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 62 00 - INSTALLATION OF MEMBRANE EQUIPMENT

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Seller shall coordinate all services and activities required by this section with the Buyer, Contractor, and the Engineer.

1. Upon completion of installation, the Engineer shall issue a “Notice of Completed Installation”.

B. Reference Specifications:

1. Section 01 66 00 - Commissioning of Membrane Equipment

2. Section 01 73 00 - Installation, Operation, and Maintenance Manuals

3. Section 46 61 34 - Containerized Membrane Filtration System

1.02 QUALITY CONTROL/QUALITY ASSURANCE (QA/QC) - NOT USED

1.03 SUBMITTALS

A. Pre-Delivery Submittals

1. The Seller shall provide to the Contractor a listing of Goods to be transported to the Point of Destination.

2. Seller shall provide to the Contractor a listing of Goods that require protection. Special storage, protection, and handling instructions shall be provided for these items.

3. In accordance with Section 01 73 00 - Installation, Operation and Maintenance Manuals shall be provided.

PART 2 -- PRODUCTS – (NOT USED)

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The Seller shall provide training to the Contractor for installation of membrane equipment. The training shall be conducted on-site by an authorized, experienced, employee of the Seller.

B. An employee of the Seller shall be present to oversee the assembly installation of the associated anchor bolts for Seller-furnished equipment.

C. Seller shall be responsible for identification of the volume and concentration of the membrane module storage solution and rinsing requirements for the membrane modules.

D. Contractor shall be responsible for making adjustments and/or modifications to the installation process that may become necessary to ensure that the equipment is properly installed.

E. After the installation is complete, the Seller, Contractor, and Engineer shall jointly perform a pre-commissioning inspection of the containerized membrane system. The inspection shall identify the following:

1. Mechanical

    a. Containerized Membrane units shall be completely installed and unit and interconnecting piping pressure tested.

    b. The Process Air System piping supplying pressurized air from the containerized membrane units to the neutralization system, citric acid system, sodium hydroxide system, sodium hypochlorite system, and calcium thiosulfate system system shall be completely installed and the piping pressure tested.

2. Electrical

    a. All local control panels shall be installed and terminations completed.

    b. All 480V, 120V, and 24VDC power supplies shall be connected and verified.

    c. The documentation associated with the inspection of electrical terminations shall be provided by the Contractor to the Seller.

F. Contractor shall be responsible for making adjustments and/or modifications to the installation process that may become necessary to ensure that all equipment is properly installed.

1. The inspection shall identify equipment that has not been properly installed, detailing the outstanding installation issues on a “punch list”, and noting the party who shall be responsible for each correction and identify the items that require correction before commissioning can begin.

2. Once the corrections identified have been made, a “Notice of Completed Installation” shall be issued by the Engineer and commissioning shall commence in accordance with the requirements of Section 01 66 00 - Commissioning of Membrane Equipment.

END OF SECTION

SECTION 01 64 00 – PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 -- GENERAL

1.01 REQUIREMENTS INCLUDED

A. Providing secure storage and protection for products to be incorporated into the Work, and maintaining and protecting products after installation and until completion of the Work.

1.02 STORAGE

A. Store and protect products immediately on delivery. Store in accordance with manufacturer's instructions, with seals and labels intact and legible.

B. Store products subject to damage by elements in substantial weather tight enclosures.

1. Maintain temperatures within ranges required by manufacturer's instructions.

2. Provide humidity control for sensitive products, as required by manufacturer's instructions.

3. Store unpacked products on shelves, in bins or in neat piles, accessible for inspection.

C. Exterior Storage:

1. Provide substantial platforms, blocking or skids to support fabricated products above ground and to prevent soiling or staining. Cover products subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.

2. Store loose granular materials on solid surfaces such as paved areas or provide plywood or sheet materials to prevent mixing with foreign matter.

a. Provide surface drainage to prevent flow or ponding of rainwater.

b. Prevent mixing of refuse or chemically injurious materials or liquids.

D. Arrange storage in manner to provide easy access for inspection.

1.03 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:

1. State of storage facilities is adequate to provide required conditions.

2. Required environmental conditions are maintained on continuing basis.

3. Surfaces of products exposed to elements are not adversely affected. Any weathering of products, coatings and finishes is unacceptable under requirements of Contract Documents.

B. Mechanical and electrical equipment which requires servicing during long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package. Comply with manufacturer's instructions on scheduled basis.

C. Any product damaged because of improper storage or protection shall be unacceptable for installation and shall be removed from the site.

1.04 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove protection when no longer needed, prior to completion of Work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Provide coverings to protect finished surfaces from damage.

1. Cover projections, wall corners, and jambs, sills and soffits of openings, in areas used for traffic and for passage of products in subsequent work.

2. Protect finished floors and stairs from dirt and damage:

a. In areas subject to foot traffic, secure heavy paper, sheet goods, or other materials in place.

b. Lay planking or similar materials in place to support movement of heavy products.

c. Store products on wood sheathing.

d. Cover walls and floor of elevator cars, and surfaces of elevator car doors, used by construction personnel.

D. Waterproofed surfaces and roofs.

1. Prohibit use of surfaces for traffic of any kind, and for storage of any products.

2. When some activity must take place in order to carry out the Contract, obtain recommendations of installer for protection of surface.

a. Install recommended protection, remove on completion of that activity.

b. Restrict use of adjacent unprotected areas.

E. Lawns and Landscaping: Prohibit traffic of any kind across planted lawn and landscaped areas.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 66 00 - COMMISSIONING OF MEMBRANE EQUIPMENT

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work: The Seller shall commission the membrane equipment and place the system into operation. Commissioning is subject to the following provisions:

1. Commissioning shall not commence until the “Notice of Completed Installation” is issued in accordance with Section 01 62 00 - Installation of Membrane Equipment.

2. Commissioning shall be completed by the Seller within the allocated time as identified in the Agreement.

3. The Engineer shall document the time when the facilities are substantially unavailable for use by the Seller to perform commissioning. Potential times of substantial unavailability include: 1) when the installation of membrane modules results in a delay to the Seller, 2) when the Engineer conducts its review of system operation and 3) circumstances beyond the control of the Seller including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the Seller, not having adequate staff from the Contractor or the Buyer. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Seller, equivalent additional commissioning time will be granted.

4. Failure to complete the Commissioning as required by this Section within the allocated time shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until commissioning is complete.

5. Upon completion of Commissioning, the Engineer shall issue the “Notice of Completed Commissioning.”

B. The Seller shall coordinate all services and activities required by this Section with the Contractor, the Engineer and the Buyer. These activities shall be coordinated with the requirements of Section 40 91 00 - Process Control Instrumentation Systems.

C. The Seller shall perform all other tests required by the Specifications.

D. Reference Specifications:

1. Section 01 73 10 - Training of Operations and Maintenance Personnel

2. Section 46 61 34 - Containerized Membrane Filtration System

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC) - NOT USED

1.03 SUBMITTALS

A. The Seller shall prepare a “Detailed Plan of Commissioning Activities” that will be used as a guideline for Commissioning of the Goods provided by the Seller. The Detailed Plan of Commissioning Activities shall be used to coordinate the activities of the Seller’s personnel. The “Detailed Plan of Commissioning Activities” will identify the Commissioning requirements for all Goods supplied by the Seller. The guidelines shall include the following minimum check items.

1. Pump(s), Metering Pumps, Blowers, Compressors and Other Rotating Equipment

    a. Filled with Oil

    b. Rotation is Proper

    c. Aligned Properly (Mechanical Seal has been set)

    d. Receives and responds to Process Control Command Signals (Discrete and/or Analog)

2. Instruments (Flow, Pressure, Level, Temperature and Analytical)

    a. Electrical Supply is Connected

    b. Software is Configured

    c. Responds to Position and Sends Discrete and Analog Signals

    d. Control Alarm Set Point has been established

    e. Instrument is calibrated

3. Switches (Flow, Pressure, Level and Temperature)

    a. Electrical Supply is Connected

    b. Sends Signal Upon Transition of State

    c. Are Calibrated

4. Automated Modulating Valves

    a. Air and/or Electrical Supply is Connected

    b. Responds to Position and Sends Feedback Signals

    c. Control Alarm Set Point has been established

5. Manual and Automatic Valves

    a. Air and/or Electrical Supply is Connected

b. Responds to and sends Feedback (Limit Switch) Signals

B. The “Detailed Plan of Commissioning Activities” will be used as a guideline for placing the facility into operation. The “Detailed Plan of Commissioning Activities” shall be coordinated with the activities of the Contractor, the Engineer and the Buyer. The guidelines shall include the following minimum check items.

1. Field Verification of Installed Equipment including:

a. Pumps, Compressors, Blowers, Tankage

b. Piping Systems and Temporary Connections

c. Electrical Control and Operator Interface Systems

2. Commissioning of Equipment

a. Feed Pumps, Filtrate Pumps (vacuum system), Vacuum Pumps, Metering Pumps, Compressors, Blowers

b. Switches, Transmitters, Analyzers

c. Modulating Manual and Automated Valves

3. Start-up Activities

a. Feed, Filtered Water and Backwash Flow Pressure and Level Control Sequences

b. Membrane Treatment Unit Operations including filtration, backwashing clean in place and membrane integrity testing.

c. Normal and Emergency Start Up and Shut Down Sequences.

d. Process Interlocks

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 COMMISSIONING

A. No system or subsystem shall be started-up for continuous operation unless all Goods, including instrumentation and monitoring systems, of that system or subsystem have been tested and proven to be operable as intended by the Contract Documents.

B. The Seller shall place the Goods into operation and perform tests to determine if equipment is operating properly. The purpose of these tests is to verify that both the System and each Unit are:

1. Properly installed

2. Operational

3. Capable of completing an operating cycles free of problems

4. Free from pump or valve cavitation, water hammer, overheating, overloading, vibration, or other operating problems.

5. The Seller shall verify that control programming has been configured with appropriate software time delays to avoid rapid pump or membrane flow cycling in response to transient dynamic hydraulic effects caused by backwash, or chemical washing cycles or other process cycles (e.g. start - up, shut down, membrane test). “Dead-heading” or any operation of any pump under a “zero-flow” or “flow condition below the pump manufacturers acceptable limits” is not acceptable. Interlocks shall be provided to prevent operation of the any pump under a “dead-headed” condition. The pump manufacturers “maximum number of pumps starts per hour” shall not be exceeded.

C. The Seller shall coordinate all activities with the Contractor, Buyer and Engineer. The types of activities to be performed by the Seller will be detailed in the “Detailed Plan of Commissioning Activities” include but not necessarily limited to the following items:

1. Initial Start Up Activities

   a. Verify Unit and Piping Installation

   b. Verify Valve Tags

   c. Verify temporary system interconnections

   d. Verify Instrumentation and Control

      1) Verify Fiber Optic System

      2) Verify PLC Communication

      3) Verify PC or Operator Interface Communication

2. Commissioning Activities

   a. Verify Pumps for Rotation

   b. Commission Compressed Air System

   c. Commission Blower System

   d. Test Modulating Valves

   e. Test Chemical Feed Systems used for feed and backwash

   f. Test Chemical Feed Systems used in Clean-In-Place

   g. Test Level Switches in Tanks

   h. Test Pressure Switches

i. Set Mechanical Seals in Pumps and Flush System

j. Test and Calibrate Process Instruments

1) Flow Meters

2) Pressure Transmitters

3) Level Transmitters

4) Turbidity Meters

5) Chlorine Residual Analyzers

6) pH/ORP Meters

7) Conductivity Meters

8) Temperature Transmitters

k. Miscellaneous Equipment

l. Field Located Manual Valves

m. Field Located Automatic Valves

n. Manual Unit Valves

o. Automatic Unit Valves

p. Flush Piping Systems

3. Start Up Activities

a. Complete Operational Readiness Test (ORT)

b. Feed Flow / Pressure / Level Control System in Manual the Automatic Mode

c. Filtrate Pressure Flow / Pressure / Level Control System in Manual the Automatic Mode

d. Backwash Flow / Pressure Level / Control System in Manual the Automatic Mode

e. Backwash Process Residuals Flow / Pressure Level / Control System in Manual the Automatic Mode

f. Filtration Units Placed into Service in Manual the Automatic Mode

g. Check Start Up Sequence in Normal and Emergency Modes

h. Check Shut Down Sequence in Normal and Emergency Modes

i. Check Process Logic Interlocks

j. Remove Temporary Interconnections

k. Disinfect Piping (if applicable)

l. Install Membrane Modules

m. Place Membrane System in Operation

1) Verify Filtration Sequence

2) Verify Backwash Sequence

3) Verify Membrane Test Sequence

4) Verify Other Seller Process Sequences

n. Chemically Clean Membrane Units

o. Perform Functional Acceptance Test

D. As a part of the commissioning, the Seller shall start-up and operate all support systems provided by or required by the Seller for operation of the system, including but not limited to chemical feed systems, instrumentation, air compression equipment, and electric controls. This testing shall demonstrate that there are no water or air leaks in the System, that the piping has been installed and connected properly, that the electrical system is operating correctly, and that the instrumentation has been properly calibrated.

E. The Seller shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning / placing the equipment into operation. The Seller shall retain the services of any manufacturers representatives as required in the Contract Documents to assist with the commissioning / placing into operation of the Goods. The costs of these services shall be borne by the Seller

F. The Seller shall oversee the installation the membrane modules by the Contractor. The location and serial number of each membrane module shall be provided using a Microsoft Excel Spreadsheet. This information will be used to document Membrane Warranty replacement. Membrane module information shall be collated and submitted to the Buyer as part of the Commissioning Test Reports Manual.

G. Once the membrane modules have been installed, the Seller shall conduct a membrane integrity test on each Unit. The Seller shall provide the Engineer with both the integrity test results for each Unit and results documenting that each installed Unit has passed the integrity test. The Seller shall repair or replace any defective membranes.

H. When requested by the Seller, the Engineer shall review the operation of the equipment to verify that the commissioning is complete.

1. The Engineer shall perform random tests to determine if the equipment is operating properly and witness various operational sequences.

2. Perform and review the results of the Functional Acceptance Test (FAT)

3. The Engineer may initiate alarm conditions to determine if the control system is functioning properly.

4. The Engineers review shall include a review of the HMI interface and PLC SCADA system commissioning requirements

5. The Engineers review shall identify any equipment that has not been properly installed, or operating, detailing the outstanding installation issues on a “punch list” and noting the party who shall be responsible for each correction and identify the items require that correction.

I. Upon satisfactory completion of the review, the Engineer shall submit to the Seller a written “Notice of Completed Commissioning”.

J. Once the “Notice of Completed Commissioning” is issued, Training of Operation and Maintenance Personnel may commence. Refer to Section 01 73 10 - Training of Operations and Maintenance Personnel.

END OF SECTION

SECTION 01 67 00 ACCEPTANCE TESTING OF MEMBRANE EQUIPMENT

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work: The Seller shall perform an Acceptance Testing of the membrane equipment. Acceptance Testing is subject to the following provisions.

1. Acceptance Testing shall not commence until the Notice of Completed Training is issued in accordance with Section 01 73 10 - Training of Operations and Maintenance Personnel.

2. Acceptance Testing shall commence within 7 days after completion of training or at a mutually agreed upon time by the Seller, Buyer, Contractor, and Engineer.

3. Acceptance Testing shall extend for a period of 30 consecutive days.

4. Acceptance Testing shall be completed by the Seller within the allocated time identified in the Agreement.

5. Failure to complete the Acceptance Testing as required by this Section within the allocated time shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until Acceptance Testing is complete.

6. The Engineer shall document the time when the facilities are substantially unavailable for use by the Seller to perform Acceptance Testing due to circumstances beyond the control of the Seller including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the Seller, not having adequate staff from the Contractor or the Buyer. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Seller, equivalent additional Acceptance Testing time will be granted.

7. The date that the Acceptance Testing ends shall be used by the Engineer for the date of the membrane equipment “Notice of Substantial Completion”. The “Notice of Substantial Completion” shall be issued by the Engineer upon completion of FINAL Operational and Maintenance Manuals.

B. Reference Specifications

1. Section 01 73 10 - Training of Operations and Maintenance Personnel

2. Section 46 61 34 - Containerized Membrane Filtration System

C. Coordination

1. The Seller shall coordinate all services and activities required by this Section with the Contractor, Buyer and the Engineer.

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC) - NOT USED

1.03 SUBMITTALS

A. Upon completion of the Acceptance Testing, the Seller shall submit to the Buyer a written report detailing the results of the Acceptance Testing, including a copy of all field notes and test data.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 ACCEPTANCE TESTING

A. Upon completion of the Operator Training in accordance with the requirements of Section 01 73 10 - Training of Operational and Maintenance Personnel, the Seller shall perform an Acceptance Test on the System.

B. The purpose of the Acceptance Testing is to demonstrate that equipment is:

1. Properly installed

2. Ready to be placed into service by the Buyer

3. In compliance with the service conditions, performance requirements, material specifications, and all other requirements of the Contract Documents

4. In compliance with the requirements of Instrumentation and Control System Testing (Reliability Acceptance Test, (RAT)).

C. The Seller shall furnish all materials, instruments, and incidental and expendable equipment required for Acceptance Testing, except where otherwise specified.

D. Throughout the Acceptance Testing period, a representative of the Seller shall be present on site during normal working hours and available via means of a pager or cellular communication during non-working hours in case of an emergency.

E. The Buyer or an authorized representative of the Buyer will be present to witness the Acceptance Testing.

F. The Seller shall keep detailed notes regarding the Acceptance Testing and record all test data and results. This will be done through operation of the data logging system. Upon successful completion of the Acceptance Testing, the Seller shall submit a written report on the Acceptance Testing, as specified in Paragraph 1.03.A of this Section.

G. The initial Acceptance Testing period will extend for 30 consecutive days with one or more Unit(s) per train of units operate at the design flow, with the other Units are equally balanced to treat the remaining raw water available for the 30- day period.

H. After the Acceptance Testing is completed, the Engineer and Buyer will meet with the Seller to determine compliance with the Contract Documents. At that time, if it is determined that the Seller has fulfilled the requirements of the Contract Documents, the Seller will be released from its on-site obligation unless otherwise retained.

I. If the Units do not meet the criteria of linear scalability as defined in the Agreement, or if the System does not perform in accordance with the Contract Documents, the Seller shall return or remain on site to perform all necessary corrections at the cost of the Seller until compliance with Contract Documents is demonstrated.

J. During the Acceptance Testing, the System shall perform in accordance with the guaranteed product water quality to allow the Buyer to discharge treated water.

K. If the Acceptance Testing is interrupted at the request of the Seller or by the non-conformance of the Seller's equipment for more than three instances or a cumulative downtime of more than six hours during the acceptance test, the Buyer or Engineer may require that Acceptance Testing be restarted from the beginning, at no cost to the Buyer.

L. Any interruption of the Acceptance Testing caused by circumstances beyond the control of the Seller shall not require the testing to be restarted from the beginning. Such events include any activities that would result in an inadvertent or unplanned shutdown of the PLC / HMI control System or otherwise interfere with the Reliability Acceptance Test. The elapsed time of Acceptance Testing prior to the interruption will be applied to the required testing period.

END OF SECTION

SECTION 01 71 13– MOBILIZATION

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Contractor shall mobilize as required for the proper performance and completion of the Work and in accordance with the Contract Documents.

B. Mobilization shall include at least the following items:

1. Moving equipment necessary for the first month of operation to the work site.

2. Installing temporary construction power, wiring, internet and lighting facilities.

3. Establishing a fire protection system.

4. Developing construction water supply.

5. Providing field offices for the Contractor and the Engineer, complete with furnishings, equipment, and utility services.

6. Providing on-Site sanitary facilities and potable water facilities.

7. Arranging for and erection of Contractor's Work and storage yards.

8. Constructing and implementing security features and requirements complying with Section 01 35 53 – Site Security.

9. Obtaining required permits.

10. Having OSHA required notices and establishing safety programs.

11. Having the Contractor's superintendent at the Site full time.

12. Submitting initial submittals.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 35 53	Site Security
01 51 00	Temporary Utilities
01 52 00	Field Office, Equipment and Services
01 55 00	Site Access and Storage
01 57 19	Temporary Environmental Controls

1.03 PAYMENT FOR MOBILIZATION

A. The Contractor's attention is directed to the condition that 5 percent of the Contract Price will be deducted from any money due the Contractor as progress payments until mobilization items listed above have been completed. The aforementioned amount will be retained by the Owner as the agreed, estimated value of completing the mobilization items listed. Any such retention of money for failure to complete such mobilization items shall be in addition to the retention from any payments due to the Contractor in accordance with Article 14 of the General Conditions.

B. As soon as practicable after receipt of the Notice to Proceed, the Contractor shall submit a breakdown to the Engineer for approval, which shall show the estimated value of each major component of mobilization. When approved by the Engineer, the breakdown will be the basis for initial progress payments in which mobilization is included.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 73 00 INSTALLATION, OPERATION AND MAINTENANCE MANUALS

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work:

1. Provide INSTALLATION, PRELIMINARY and FINAL Operational and Maintenance (O&M) Manuals for use by the Contractor and the Buyer.

a. The term "Operation and Maintenance Manual" includes all product related information and documents which are required for preparation of the Membrane Filtration System O&M Manual, and data that is required for inclusion by current regulations of any participating government agency or as a provision of a membrane system warranty.

b. Failure to provide the INSTALLATION, PRELIMINARY and FINAL Operational and Maintenance (O&M) Manuals as required by this Section within the allocated time shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until Manuals have been received. Required Delivery for O&M Manuals are as follows:

1) INSTALLATION Manuals are due 30 days before the Goods are delivered to the Point of Destination.

2) PRELIMINARY O&M Manuals are due 30 days before Commissioning.

3) FINAL O&M Manuals are due 30 days after the completion of Acceptance Testing.

c. The term component equipment supplier is used to describe a manufacturer’s Goods purchased by the Seller and incorporated into the Membrane Filtration System.

d. The O&M Manual shall include, but not be limited to, the following:

1) Equipment function, operating characteristics, limiting conditions, operating instructions and procedures for startup, normal and emergency conditions, shutdown and storage

2) Safety considerations relating to installation, operation and maintenance procedures

3) Installation procedures

4) Calibration procedures

5) Routine and preventive maintenance instructions

6) Procedures for disassembly, reassembly, alignment, adjustment, and inspection instructions

7) Recommended spare parts list to maintain equipment in service

8) Special Tools:

   a) For Seller equipment, provide list of special tools included and required for installation checking, testing, parts replacement, and maintenance

   b) For component equipment, a list of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance with current price information

9) For component equipment provide name, address and telephone number for local sources of equipment and/or replacement parts

10) Operational log sheets and maintenance schedules

11) Material Safety Data Sheets (MSDSs) for any applicable item (chemicals, oils, lubricants, etc) provided by the Seller

12) Furnish lubricants of the type and grade necessary to meet the requirements of the equipment. Provide lubricants that are NSF Standard 61 approved as food grade and that are compatible for use in public water supplies

13) Warranty Information, Bond(s), and Service contract(s), if applicable

14) Equipment Specific and Factory Test Report information shall include:

   a) Tag name, Model and Serial number of the equipment provided

   b) Name, address, and phone number of manufacturer, manufacturer's local service representative

   c) Factory Test Reports where applicable

   d) Approved Shop Drawings (including equipment drawings, schematics, circuit diagrams)

e. Routine and preventive maintenance instructions include all information and instructions required to keep equipment properly lubricated, adjusted, and maintained so that the item functions as intended throughout its full design life. Routine and preventive maintenance instructions shall include, but not be limited to, the following:

   1) Written explanations with illustrations for each preventive maintenance task

   2) Recommended schedule for execution of preventive maintenance tasks

   3) Lubrication charts shall include a table of alternative lubricants naming at least two alternate lubricant manufacturers, with applicable product numbers, for each application

   4) Troubleshooting instructions

5) List of required maintenance tools and equipment

B. Reference Specifications

1. Section 46 61 34 - Containerized Membrane Filtration System

C. Coordination

1. The Seller shall coordinate the delivery and incorporation of O&M Manuals prepared for this project by the Seller or provided from their component equipment suppliers. The Seller shall develop an O&M Manual for the equipment and systems designed and provided by the Seller under this contract.

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC))

1.03 SUBMITTALS

A. General

1. Installation, Commissioning, Training of any process, or piece of equipment shall not be permitted until the respective INSTALLATION or PRELIMINARY manuals have been received and approved by the Engineer as being sufficient in content to allow the completion of the work.

2. O&M Manuals shall be submitted in three ring binders with a table of contents and index tabs to identify the various items.

3. The table of contents shall reference the applicable specification section(s) for each item and shall be included in each volume of multi-volume manuals.

4. O&M manuals shall use dividers and indexed tabs between major categories of information such as Operating Instructions, Preventive Maintenance Instructions, etc.

5. O&M manuals shall use 8-1/2-inch by 11-inch acid free paper of high rag content and quality. All text must be legible, type-written or machine printed originals or high quality copies.

6. Each page shall have a binding margin of approximately 1-1/2 inches and be punched for placement in a three-ring " D" style loose-leaf binder, which shall be provided by the Seller along with the submittal. Each binder shall be no more than 3 inches.

7. Drawings: Provide full size blueprints (24 x 36) and Half-size black line (11 x 17) reproductions shall be provided for all project drawings. 11-inch x 17- inch drawings shall be bound in a separate binder. 11-inch x 17-inch drawings shall not be folded and placed in any project binder designed for 8½ inch x 11 inch pages.

8. Electronic File Format

a. All Seller O&M Manual information shall be supplied to the Buyer as electronic file format that it was originally developed and in condensed portable document format (.PDF format). The specifications for PDF generation are as follows:

1) The acceptable format is Portable Document Format (PDF): Adobe Acrobat or Adobe Acrobat Exchange

2) The initial filename for the EOM submittal is provided with the request for final O&M manuals. The filename is posted near the top of the review form. Filenames use the “eight dot three” convention (XXXXX_YY.PDF) where XXXXX is the specification section number and YY is an ID number. If technical problems require you to break the submittal into more than one file then add a letter extension to the end of each filename. (example: 19876_01A.PDF) Keep the number of files to a minimum.

3) Scan images at a resolution of 400 dpi or greater. Perform Optical Character Recognition (OCR) capture on all images. Achieve OCR with the “original image with hidden text” option (as seen in Adobe Acrobat Exchange 4.05).

4) Create one PDF document (PDF file) for each equipment O&M Manual. The entire manual is converted to a single PDF file via scanning or other method of conversion. Drawing or other graphics must be converted to PDF format and made part of the one PDF document. Rotate pages that must be viewed in landscape to the appropriate position for easy reading. Word searches of the PDF document must operate successfully. (proof of OCR)

5) Create a bookmark in the navigation frame, for each entry in the Table of contents. Three levels deep is usually enough (i.e. Chapter, Section, Sub-section)

6) Generate thumbnails for each completed PDF file.

7) Set the opening view for PDF files as follows:

a) Initial view: Bookmarks and page

b) Magnification: Fit in window

c) Open to the cover page of the manual, with bookmarks to the left, and the first bookmark linked to the table of contents.

b. All component equipment manuals shall be provided in .PDF format.

c. All Project drawings shall be provided in AutoCAD 2000 and .PDF format.

9. Equipment Identification

a. Identify products and components by their Tag and descriptive names. The use of cryptic model or catalog numbers or letters for identification shall not be acceptable.

b. Indicate all components of the equipment on catalog pages by bold markings or some other clearly definable medium for ease of identification. All markings shall be readable if photocopied.

B. Letter of Transmittal:

a. The Seller shall provide a Letter of Transmittal with each submittal and include the following in the letter:

b. Date of submittal.

c. Contract title and number.

d. Seller's name and address.

e. A list of the attachments and the Sections of the Manual to which they relate.

f. Reference to or explanation of related submittals already made or to be made at a future date.

C. The Seller shall prepare INSTALLATION Manuals for the Installation of the Goods by the Contractor.

1. The Seller shall submit six copies marked "INSTALLATION" of each required O&M manual to the Contractor. Each manual shall include an electronic version containing the information contained in the manual. Distribution by Contractor shall be as follows:

a. The Contactor shall retain 3 copies

b. The Engineer shall receive 2 copies

c. The Buyer shall receive 1 copy

2. The Seller shall organize the "INSTALLATION" manuals as follows

a. Seller Equipment Installation Manual

1) Seller Equipment Installation Instructions

2) Contractor Training Information

3) Painting Touch up and Repair Instructions

4) Equipment Cross-Reference Schedules

a) For all tagged devices supplied, the Seller shall develop an "Cross Reference Schedule" that matches the Tag to the appropriate equipment manual. The equipment schedule shall include the pertinent information associated with the equipment including tag number, description, functional name location, component equipment model, part number, size, materials, accessories and range. The equipment cross-reference schedule shall be provided in the form of a Microsoft Excel (.XLS) spreadsheet.

b. Component Equipment O&M Manuals

1) Includes all Division 46, including Section 46 61 34 - Containerized Membrane Filtration System, (excluding membrane equipment) and Division 43 approved or “as constructed by Seller” shop drawing submittals and equipment Installation, Operational and Maintenance Manuals.

c. Instrumentation and Control Equipment Manuals

1) Includes all Division 40 approved or “as constructed by Seller” Shop Drawing Submittals and Equipment Installation Operational and Maintenance Manuals.

d. Electrical Equipment Manuals

1) Includes all Division 26 approved or “as constructed by Seller” Shop Drawing Submittals and Equipment Installation, Operational and Maintenance Manuals.

e. All “As Constructed” Project Drawings

D. PRELIMINARY O&M Manual:

1. The Seller shall submit six copies marked “PRELIMINARY” of each required O&M manual and the training plan. Each manual shall include an electronic version containing the information contained in the manual.

2. The Seller shall organize the PRELIMINARY O&M Manuals as follows:

a. Seller Equipment O&M Manual

1) Includes O&M and Preventive Maintenance Instructions

2) Includes Detailed Plan of Commissioning Activities

3) Includes the Equipment Cross-Reference Schedule

b. Component O&M Manuals

1) Includes all Division 5, Section 46 61 34, Containerized Membrane Filtration System, (excluding membrane equipment) and Division 15 approved or “as constructed by Seller” equipment Installation, Operational and Maintenance Manuals.

c. Instrumentation and Control O&M Manuals

d. Electrical Equipment Manuals

e. Equipment Specific and Factory Test Reports Manual

f. Seller and Component Equipment Suppliers Training Manual(s)

g. All “As Constructed” Project Drawings

E. After the Acceptance Testing has been completed the Seller shall revise and resubmit the FINAL O&M Manuals for the project. Eight final copies of each of the required Operation and Maintenance Manuals shall be submitted. Each manual shall contain an electronic version containing the information contained in the manual.

1. FINAL O&M Manual(s):

2. The Seller shall submit six copies marked “FINAL” of each required O&M Manual. Each manual shall include an electronic version containing the information contained in the manual.

a. The Seller shall organize the FINAL O&M Manuals as follows:

1) Seller Equipment O&M Manual

2) This O&M Manual will be provided “as new in its entirety.”

3) Includes O&M and Preventive Maintenance Instructions

4) Includes an equipment cross-reference schedule

5) Includes a FINAL electronic version

b. Component O&M Manuals

1) This Manual will include only changes from the PRELIMINARY to FINAL Versions. The Seller shall provide new Manual Covers or Binders

2) Includes a FINAL electronic version

c. Instrumentation and Control O&M Manuals

1) The Seller PLC/HMI Manuals will be provided “as new in its entirety.”

2) The component equipment manuals include only changes from the PRELIMINARY to FINAL Versions. The Seller shall provide new Manual Covers or Binders

3) Includes a FINAL electronic version.

d. Electrical Equipment Manuals

1) The Electrical Equipment Manuals include only changes from the PRELIMINARY to FINAL Versions. The Seller shall provide new Manual Covers or Binders

2) Includes all Electrical, Shop Drawing Submittals and Component Equipment O&M Manuals

3) Includes a FINAL electronic version

e. Equipment Specific and Factory Test Reports Manual

1) The FINAL Factory Test Report Manual shall include only changes from the PRELIMINARY to FINAL Versions for Component Equipment. The Seller shall provide new Manual Covers or Binders.

f. Commissioning Test Reports Manual shall include:

1) Results of all installation inspection, field calibration, and field testing reports prepared during the commissioning of the facility

2) Results of membrane module installation and integrity testing

3) Results of Acceptance Testing

g. All “as installed” project drawings will be provided “as new in its entirety” and include a FINAL electronic version.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

FSECTION 01 73 10 - TRAINING OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work

1. This Section describes training of membrane systems. Balance of equipment training is described in Section 01 79 00 – Owner Staff Training.

2. The Seller shall provide formal training of the Buyers' personnel. Training shall commence after the "Notice of Completed Commissioning" is issued.

   a. Training of the Buyer's personnel shall commence within a period of 14 days after the "Notice of Completed Commissioning" has been issued as mutually agreed to by the Buyer, Engineer, Contractor and Seller.

   b. Training shall be conducted for first shift during normal working hours.

   c. Training shall be completed within the time allocated in the Agreement.

   d. The Engineer shall document the time when the facilities are substantially unavailable for use by the Seller to perform training due to circumstances beyond the control of the Seller including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the Seller, not having adequate staff from the Contractor or the Buyer. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Seller, equivalent additional time for training will be granted.

   e. Failure of the Seller to complete the Training as required by this Section within the allocated time, shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until Training is complete.

   f. Upon successful completion of the Training required by this Section, the Engineer will issue a "Notice of Completed Training".

   g. The Seller shall maintain record of the individuals that have completed training and provide information required for the documentation of Professional Development Hours required for the Buyer's personnel.

3. The Seller shall provide the services of factory-trained specialists to train the Buyer's personnel in the recommended operation and the preventive maintenance procedures for all equipment provided by the Contract Documents.

4. The Seller shall provide a combination of classroom and hands-on training. All training shall be conducted at the Buyer's location.

5. The following Levels of Training Shall Be Provided.

Level of Training	Number of Shifts	Maximum Number of Participants	Classroom Training (Hours)	Hands-On Training (Hours)
Membrane System	1	8	8	16
Mechanical Equipment	1	8	8	16
Instrumentation and Control Equipment	1	4	8	16
PLC / HMI	1	4	16	16

6. Hands-On Training shall be limited to groups of 8. In the event that more than 8 personnel are to be trained, multiple hands-on training sessions shall be conducted.

7. The Seller shall be responsible for all costs associated with training and shall provide required materials, texts, and supplies.

8. Training shall be conducted in normal eight (8) hour working days until conclusion of the training course.

9. Training sessions may be video recorded by the Buyer at the Buyer's expense.

10. Training material shall be provided to the Buyer in written and electronic format.

11. Training shall be performed by the Seller and component equipment suppliers. The Seller shall be responsible for the training on the design and operation of the equipment and systems provided. This includes:

    a. Membrane System

        1) Membrane Filtration Theory

        2) Membrane Filtration System

        3) Membrane Filtration Units

        4) Membrane Filtration Processes

            a) Start Up, Shut Down

            b) Filtration, Backwashing

            c) Maintenance Cleaning, Chemical Washing, Backwash and Clean in Place

d) Integrity Testing and Module Repair

5) Routine and Non-Routine Maintenance

b. Component Equipment Training

1) Equipment, Equipment (including pumps, compressors)

2) Mechanical, Equipment (valves, actuators, and positioners)

c. Instrumentation and Control Component Equipment Training

1) Switches

2) Meters and Transmitters

3) Analyzers

d. Instrumentation and Control Process Logic Control/HMI Training

1) Process Logic Control Equipment

2) HMI System Training

12. Component Equipment Suppliers: The Seller shall retain the services of manufacturer's representative(s) for training of the following equipment provided by the Seller.

a. Pumps

b. Compressors

c. Process Logic Control Equipment

d. HMI System Programming

e. Other equipment provided by the Seller where the Seller is not qualified to provide authorized factory level training

B. Reference Specifications

1. Section 01 66 00 - Commissioning of Membrane Equipment

2. Section 01 67 00 - Acceptance Testing of Membrane Equipment

3. Section 01 73 00, Installation, Operation and Maintenance Manuals

4. Section 46 61 34 - Containerized Membrane Filtration System

C. Coordination:

1. The Seller shall coordinate these services at times acceptable to the Buyer, with a minimum of 5 days prior notice.

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC)

1. The qualifications of specialists shall meet the requirements of this Section and are subject to approval by the Engineer.

1.03 SUBMITTALS

A. Training Manuals shall be provided with the PRELIMINARY O&M Manuals. Refer to Section 01 73 00 - Installation, Operation and Maintenance Manuals.

B. The Seller shall develop and submit to the Engineer and Buyer a Training Manual. The Training Manual Plan shall include the elements presented in this Section or as required by the Seller or component equipment supplier.

C. The Seller shall prepare a Training Lesson Plan, provide qualified instructors, and schedule the training in an organized manner.

1. Proposed lesson plans for scheduled instruction shall be submitted 15 days prior to the commencement of training. Lesson plans shall be approved by the Engineer a minimum of 5 days prior to scheduled instruction. All training material shall be provided to the Buyer in electronic format.

2. Credentials for the Seller’s designated instructor(s) shall be submitted thirty (30) days prior to the commencement of training. Credentials shall include a brief resume and specific details of the instructor(s) pertaining both to personal experience operating and maintaining the specified equipment and conducting operation and maintenance for the same equipment.

3. The Seller’s proposed lesson plans shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed lesson plan. "Hands-on" demonstrations planned for the instruction shall be described in the lesson plan.

4. The Seller shall indicate the estimated duration of each segment of the training in the lesson plan.

5. Submit information as required by the local primacy agency in support of Professional Development Hours.

1.04 PRODUCT DELIVERY STORAGE AND HANDLING (NOT USED)

1.05 SPECIAL PROJECT CONSIDERATIONS

A. Training Aids

1. The Seller’s instructor shall incorporate training aids as appropriate to assist in the instruction. As a minimum, the training aids shall include text and figure handouts. Texts shall be bound within three-ring binders. Other appropriate training aids are:

a. Audio-visual aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets)

b. Equipment cutaways and samples (e.g., spare parts and damaged equipment)

c. Tools (e.g., repair tools, customized tools, measuring and calibrating instruments)

2. The Seller’s instructor shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are required. Handouts planned for the instruction shall be attached with the manufacturer's proposed lesson plan.

B. “Hands-On Demonstration”

1. The Seller’s instructor shall present "hands-on" demonstrations of operations and maintenance of the Seller supplied and component equipment. The proposed "hands-on" demonstrations should be described in the Seller’s proposed lesson plan.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 OPERATOR TRAINING

A. Training: The instruction lesson plan shall include the following as a minimum:

1. Equipment Operation:

a. Describe equipment's operating (process) function

b. Describe equipment's fundamental operating principals and dynamics

c. Identify equipment's mechanical, electrical, and electronic components and features

d. Identify all support equipment associated with the operation of subject equipment (e.g., compressed air intake filters, valve actuators, motors)

e. Recommend standard operating procedures to address start-up, routine monitoring, and shut-down of the equipment

2. Detailed Component Description:

a. Identify and describe in detail each component's function

b. Group related components into subsystems, where applicable. Describe subsystem functions and their interaction with other subsystems

c. Identify and describe in detail equipment safeties and control interlocks

3. Equipment Preventive Maintenance (PM):

a. Describe PM inspection procedures required to:

1) Perform an inspection of the equipment in operation

2) Spot potential trouble symptoms and anticipate breakdowns

3) Forecast maintenance requirements (predictive maintenance)

b. Define the recommended PM intervals for each component

c. Provide lubricant and replacement part recommendations and limitations

d. Describe appropriate cleaning practices and recommend intervals

e. Identify and describe the use of special tools required for maintenance of the equipment

f. Describe component removal/installation and disassembly/assembly procedures

g. Perform "hands-on" demonstrations of preventive maintenance procedures

h. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate

i. Define recommended torquing, mounting, calibration, and/or alignment procedures and settings, as appropriate

j. Describe recommended procedures to check/test equipment following a corrective repair.

4. Equipment Troubleshooting

a. Define recommended systematic troubleshooting procedures

b. Provide component specific troubleshooting checklists

c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting

END OF SECTION

SECTION 01 74 00 MEMBRANE SYSTEM AND MODULE WARRANTY

PART 1 -- GENERAL

1.01 SUMMARY

A. Section includes:

1. Membrane system and module warranty information.

2. This section covers the membrane system equipment and module warranty. This section addresses the requirements in conjunction with the provisions of Paragraphs 9.01, 9.03, and 9.04 of the General Conditions.

B. Related specification sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.

2. Division 01 - General Requirements.

3. Section 46 61 34 - Containerized Membrane Filtration System

1.02 QUALITY ASSURANCE

A. Referenced standards:

1. ASTM International:

a. D6908, Standard Practice for Integrity Testing of Water Filtration Membrane Systems.

B. Seller’s Quality Assurance/Quality Control (QA/QC) Procedures

1. Submit for approval, prior to the shipment of the membrane modules, reports in letter format for each membrane module. At a minimum, the reports shall include:

a. The membrane module model and part number, manufacturing lot number and serial number. Indicate the nominal and absolute pore size, inside and outside fiber diameter, effective fiber length, and effective feed side surface area of the membrane module.

b. The membrane module normalized specific flux (permeability, gfd/psi at 20°C).

c. A certification by the membrane module supplier that:

1) Each membrane module has passed the Seller’s QA/QC (integrity) tests.

d. Certification of wet testing for each membrane module conducted at the Seller's facilities. Seller shall certify that each membrane module has passed the QA/QC tests for membrane element integrity. Acceptable QA/QC tests include bubble point or pressure hold tests above the minimum value recommended by the Seller and approved by the Engineer.

e. Identify modules that have undergone pinning or repair for more than 0.1 percent of original fibers at the factory.

2. Certificates of Warranty

a. Submit a listing of chemical constituents, concentrations and exposure times that would void the membrane warranty.

1.03 DEFINITIONS

A. Log Reduction Value (LRV): The filtration removal efficiency expressed as $\log_{10}$ for a target organism or surrogate.

B. Membrane Module(s): Hollow fiber membranes arranged as a module that is a sub-assembly of a MF/UF Unit.

C. Membrane Integrity Failure Occurrence:

1. A loss of integrity (e.g., partial or complete fiber breaks) that results in less than 4-log (LRV of 4 or 99.99 percent filtration efficiency for a removal of 3 micron or larger particles) as determined by an air pressure based Direct Integrity Test such as the:

a. Pressure Decay Test.

b. Diffusive Airflow Test.

c. Correlated Airflow Measurement Test:

1) A pressure decay test, applying Hagen-Poisseville equation per ASTM D6908.

d. Other conforming integrity tests that satisfy the criteria for test resolution and sensitivity as described by any recognized independent method developed by a consortium of membrane module manufacturers or described and accepted as a method by the primacy agency.

2. MF/UF System: The complete MF/UF System is comprised of multiple MF/UF Units and all ancillary equipment.

D. MF/UF Unit(s): One (1) complete filtration unit including valves, pumps, controls, and piping capable of producing filtered water.

E. Substantial Completion: See Division 0 - General Conditions.

1.04 SUBMITTALS

A. Shop Drawings

1. Membrane Warranty

    a. Submit design calculations to substantiate the 4-Log Membrane LRVs for air pressure integrity testing. Perform calculations based upon a broken fiber·lumen(s) or a microporous defect of 3 microns to determine the worst-case membrane integrity defect scenario.

    b. Provide a listing of chemical constituents, concentrations and exposure times that would result in voiding the membrane warranty.

    c. For each of the above chemical constituents, identify the instrumentation required and alarm limits necessary to satisfy the warranty provisions of this section.

2. MF Membrane Modules:

    a. Include module construction details.

        1) Materials of construction.

        2) Dimensions.

        3) Standard commercial part numbers and materials for elastomeric seals. Note that Buna-N seals are not acceptable.

    b. Include standard performance parameters.

        1) Operating temperature.

        2) pH and oxidant tolerance (continuous and intermittent).

        3) Range of membrane flux.

        4) Clean water normalized specific flux (permeability or resistivity).

        5) Minimum bubble point or maximum pressure decay test parameters.

    c. Include storage and handling requirements.

    d. Provide standard operating and maintenance data including storage solutions (concentration and volume) used during shipment and recommended rinsing solutions (concentration and volume) and long-term/short-term storage protocols.

B. Factory Test Reports

1. Prior to delivery of the membrane modules, submit the following:

    a. Seller shall identify each membrane module by a unique serial number and indicate the membrane lot.

b. Seller shall provide the membrane specification sheets that specify each membrane module's normalized specific flux (gfd/psi at 20°C), nominal pore size, and the nominal inside and outside surface area of the filter module.

c. Certification of wet testing for each membrane module conducted at the Seller's facilities. Seller shall certify that each membrane module has passed the QA/QC tests for membrane element integrity. Acceptable QA/QC tests include bubble point or pressure hold tests above the minimum value recommended by the membrane module supplier and as approved by the Engineer.

C. Certificates of Warranty

1. The listing of chemical constituents, concentrations, and exposure time that would void the membrane warranty.

1.05 MEMBRANE SYSTEM WARRANTY

A. During the Correction Period, the Seller shall furnish an equipment warranty certificate assuring the containerized membrane filtration units and system (including membrane modules) will meet the service conditions specified in Section 46 61 34 - Containerized Membrane Filtration System, Paragraph 2.01.

B. Seller warrants satisfactory performance of the Goods to achieve equipment performance (e.g., design flows, water recovery, backwash, chemical washing, and Clean-In-Place (CIP) intervals) and water quality (e.g., integrity failure) objectives and complies with the concept of linear scalability as defined in the Agreement.

C. In the event that the Buyer does not believe that the Goods meet the specifications, including the criteria of linear scalability, the Buyer shall notify the Seller that the conditions for a breach of contract exist. Seller shall provide at no cost to the Buyer pilot equipment of the type and kind evaluated during the pilot testing, if not available to the Buyer, to verify the compliance with the specifications. In the event that the Buyer determines that the equipment does not comply with the specifications including the concept of linear scalability, the Seller shall provide an acceptable remedy to the Buyer in accordance with the General Conditions. If an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

D. If the Goods are non-conforming and unable to conform to the equipment performance objectives for criteria other than linear scalability, the Buyer will notify the Seller in accordance with the procedures identified in Paragraph 9.03 of the General Conditions. Buyer shall make available to the Seller electronic records for Seller review. Seller shall be given 10 days to develop a plan to remedy the non-conformance.

E. If within 60 days after the notification to the Seller it has become apparent to the Buyer that the remedy is not acceptable, the Buyer will provide notice to the Seller that the conditions for breach of contract exist. If within 30 days an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

F. Buyer recognizes that to remedy system warranty provisions, the Seller may need to modify operational protocols. Seller recognizes that any change to the operational protocols must be acceptable to the Buyer. Buyer recognizes that any changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

1. That the specified design parameters (e.g., production capacity, water quality, system recovery, and chemical cleaning interval) are obtained.

2. That the change in operational parameters and protocols (e.g., backwash, chemical washing, or chemical cleaning) will not represent an increase in operational or membrane replacement costs to the Buyer.

1.06 MEMBRANE MODULE WARRANTY

A. General:

1. Seller warrants that the membrane modules will be used for the treatment of water for drinking purposes and that in accordance with Paragraph 5.08 of the General Conditions the membrane modules are fit for the intended purpose.

2. Membrane modules and elements purchased by the Buyer or otherwise provided under the Agreement or as a future membrane replacement shall be provided with the same warranty as the membrane modules and elements provided as part of the original equipment installation.

3. Seller warrants that the membrane modules and elements will be free from non-conformance in:

a. Materials.

b. Workmanship.

c. Membrane integrity failure.

d. Irreversible flux loss.

B. Membrane Module and Element Warranty Periods

1. Seller shall warrant the performance of the supplied MF/UF membrane modules for a period of not less than ten (10) years (inclusive of the five (5) years full replacement warranty period) from the date of Substantial Completion.

a. The warranty shall guarantee the performance of the membrane modules so as to meet the MF/UF system design and performance criteria specified in Section 46 61 34, Containerized Membrane Filtration System.

b. Membrane modules that within the first year become non-conforming, as defined by the requirements specified herein, must be replaced with new membrane modules at no cost to the Buyer.

2. Seller’s membrane module and element warranty periods have been established in the Proposal.

a. Seller's membrane module warranty period shall commence the day water first touches membrane modules or 6 months after shipment (whichever comes first) and continue until the end of the pro-rata warranty period submitted by the Seller with the Bid.

b. The membrane module and element warranty periods shall consist of two (2) parts: a full replacement warranty period and a pro-rata warranty period.

1) The full replacement warranty period shall last for a period of at least five (5) years after the day water first touches membrane modules or 18 months after delivery (whichever comes first) as described below:

a) For membrane modules or elements supplied as part of the original equipment installation, the day water first touches membrane modules or 18 months after delivery (whichever comes first) is when the full replacement warranty period commences.

b) For membrane modules or elements provided after the day water first touches membrane modules or 18 months after delivery (whichever comes first), the full replacement warranty period begins the date the membrane module or element is placed into service.

c) Buyer shall record and maintain records of the date of installation for all membrane modules and elements.

2) The pro-rata warranty period of five (5) years shall commence with the end of the full replacement warranty period and last until the end of the pro-rata warranty period as submitted by the Seller in the Bid.

C. In the event that the Goods do not meet the performance requirements specified, including the criteria of linear scalability, the Buyer shall notify the Seller in writing requesting warranty replacement modules.

1. Following return notification, the Seller shall have an optional 10-day period to provide on-site troubleshooting and/or repair of the defective Goods.

D. In the event that the capacity or quality cannot be regained through these efforts, an adequate number of modules will be replaced as per the terms of the warranty to recover system performance within the parameters specified in Section 46 61 34, Containerized Membrane Filtration System.

E. If within 60 days after the notification to the Seller it has become apparent to the Buyer that the remedy is not acceptable, the Buyer will provide notice to the Seller that the conditions for breach of contract exist.

1. If within 30 days following such notice an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

F. Buyer recognizes that to remedy system warranty provisions, the Seller may need to modify operational protocols.

1. Seller recognizes that any changes to the operational protocols must be acceptable to the Buyer.

2. Buyer recognizes that any changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

    a. That the specified design parameters (e.g., production capacity, water quality and system recovery) are obtained.

    b. That the change in operational parameters and protocols (e.g., backwash, chemical cleaning, or recovery cleaning) will not represent an increase in operational or membrane replacement costs to the Buyer.

    c. Revised protocol is subject to review and approval by the Buyer and/or Engineer.

G. Limitation of Membrane Module and Element Warranty

1. Buyer recognizes that the occurrence of any of the following shall void the membrane module and element warranties:

    a. Physical damage or faulty installation of the membrane modules or elements by anyone other than Contractor, Seller, or Seller's authorized representative.

    b. Unauthorized alteration of components manufactured by the Seller.

    c. Catastrophic exposure to chemicals or deleterious substances not normally associated with water treatment as a result of accidents, vandalism or other acts that are outside the bounds of routine and normal water treatment plant operations.

    d. Use of water treatment chemicals, chemical cleaning solutions or cleaning procedures other than chemicals, solutions and procedures approved by the Seller.

    e. Exposure of the membrane modules or elements to treated water or water treatment chemicals at concentrations above levels or contact times acceptable to the Seller.

        1) Seller is responsible for providing the Buyer a listing of the known water treatment and cleaning chemicals and concentrations and times of exposure that could result in membrane damage.

        2) Operation or cleaning of any membrane module or element outside the stated chemical limits shall void the remaining portion of the membrane module or element warranty.

    f. Improper maintenance of equipment, as defined in the Technical/O&M Manual.

    g. Failure of the Buyer to maintain operational logs as required by the Seller.

        1) The maintenance of electronic logs is subject to the following conditions:

            a) Seller is responsible for providing the Buyer a listing of the operational data points that are to be electronically logged.

b) Seller is responsible for the control programming of data points that are to be electronically logged.

c) Seller shall identify minimum frequencies of logging of all operational data points required by the Seller to maintain membrane module and element warranty provisions.

d) Seller shall establish the alarm and shutdown limits that would result in the operation of the equipment outside of Seller acceptable limits.

e) Seller shall be solely responsible for the identification and programming of system interlocks that would result in the operation of the system outside of the parameters required by the Seller.

(a) Buyer will not be responsible for errors in Seller developed programming that would result in improper operation of the system.

h. In the event of a warranty claim, failure of the Buyer to provide the Seller with operational logs.

2. Buyer will assume responsibility of maintaining a hand-written log if an occurrence develops that is totally outside the bounds of routine and normal operation or automated operation.

a. Such items would include obtaining water analyses, or catastrophic events (e.g., discharges of foreign objects or chemicals that are outside the normal operation of a water treatment facility).

3. Changes in the Seller established operational and maintenance guidelines cannot be applied retroactively to invalidate the membrane module or element warranties.

4. Seller is solely responsible for the identification of water quality parameters normally associated with water treatment and water treatment chemicals and cleaning solutions (for procedures approved by the Seller), and for identification of instrumentation and control programming required to satisfy and maintain membrane module and element warranty provisions for operation and cleaning.

5. Buyer recognizes that to satisfy warranty requirements, the Seller may provide membrane replacement modules or elements that embody changes in module or element design and construction features.

a. Buyer recognizes that the replacement of membrane modules or elements pursuant to this warranty with a different membrane module or element is acceptable under the following conditions:

1) That the specified design and operational parameters (e.g., design flows, water quality, system recovery and chemical cleaning intervals) are obtained.

2) That the change in membrane modules or elements will not represent an increase in the operational or membrane module or element replacement costs to the Buyer.

3) The revised module or element must also be in compliance with regulatory requirements.

H. Membrane Module and Element Pricing

1. Seller shall establish the membrane module and element prices (as indicated in the Proposal Pricing Form) and guarantees that:

a. Membrane modules and elements have been provided to the Buyer at prices not exceeding the prevailing market price.

b. In the Proposal Pricing Form, the Seller shall indicate the cost escalated Consumer Price Index (CPI) used to calculate the replacement price.

1) The CPI adjustment is the most recent Month CPI Index divided by the CPI Index for the month of the Bid submittal.

c. The CPI Index to be used shall be the "CPI-U, US City Average, all Items (non-seasonally adjusted)" as compiled by the U.S. Department of Labor.

2. During the full replacement warranty period, the Seller shall provide replacement modules and elements for non-conforming modules and elements at no cost to the Buyer.

3. Module and element prices during the pro-rata warranty period shall be calculated as follows:

~~a.~~ Pro Rata Module Price = (Module Price x applicable CPI adjustment x Months of Beneficial Use)/Membrane Module Pro-Rata Warranty Period (Months).

I. Membrane Module Integrity:

1. Membrane Integrity Test Frequency:

a. Membrane Integrity testing shall be performed daily.

2. LRV Determination

a. The operating Log Reduction Value (LRV) shall be determined at the maximum design flux and maximum Transmembrane Pressure (TMP), if calculated using the test result on an intermittent basis.

b. The LRV shall be determined at the operating flux and TMP, if calculated using the test result on a continuous basis using the result of the last direct integrity test.

c. The LRV calculation shall include the applicable adjustment for the "concentration factor" as described in the Direct Integrity Test provisions of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

d. If empirical data is used for the calculation of LRV, the Seller will provide adequate evidence (e.g., results of challenge testing at the Seller membrane integrity test pressure, air and water flow/pressure drop data) to support the correlation between air pressure integrity test result and LRV based upon a “flow limiting orifice” criteria for a broken lumen at the membrane - membrane pot interface for approval by the Engineer.

3. Membrane Integrity Failure

a. Membrane modules shall be considered to have non-conforming integrity failure if the number of Membrane Integrity Failure Occurrences per membrane unit exceeds three (3) occurrences in a three (3) month period or six (6) occurrences in a 12 month period. A failing membrane integrity test shall be considered a Membrane Integrity Failure Occurrence if the problem is resolved by pinning of a membrane fiber.

1) Seller will define the number of fiber breaks per Unit that constitutes Membrane Integrity Failure Occurrence for their particular membrane module.

b. If a Membrane Integrity Failure Occurrence is identified:

1) Module(s) may be isolated from service and the system retested. If isolation of the modules(s) restores Unit integrity requirements, the Unit may be placed back into service.

2) The individual modules shall be pin repaired, or replaced if pin repair is not possible, and the Unit will be retested and returned to service. The membrane module serial number and number of membrane fibers repaired shall be recorded. The Membrane Integrity Failure Occurrence shall be documented by the Buyer.

3) For subsequent Membrane Integrity Failure Occurrences, module(s) may be isolated from service and the Unit placed back into service unless the cumulative area isolated from the Unit reduces the MF/UF System Firm Capacity below that which is required.

4) If module(s) cannot be isolated from service, then all defects in that Unit shall be repaired or replaced (if repair is not possible), and the Unit retested and placed back into service.

5) The membrane module serial number and number of membrane fibers repaired shall be recorded.

c. Individual membrane module(s) shall be considered to have integrity failure under the following conditions:

1) Prior to Acceptance Testing

a) If more than 0.25 percent of the fibers are pinned prior to commencement of the Acceptance Testing.

2) After Acceptance Testing

a) If for a single membrane module, more than 0.05 percent of the fibers have required repair (e.g., by pinning or gluing) in any 12 consecutive months.

3) Anytime

a) An individual membrane fiber shall be defined as requiring repair if it visually leaks during an air pressure integrity test at the integrity test pressure.

b) If a module assembly fails the air pressure integrity test and cannot be repaired by pinning or gluing, then the module is considered defective.

c) If the cumulative repairs from the date of manufacture raise the flux rate 0.1 percent above the design flux rate.

d) If more than 0.5 percent of the fibers have required repairs over the life of the membrane module. An individual membrane fiber shall be defined as requiring repair if it visually leaks during an air pressure integrity test at the integrity test pressure.

d. If a membrane unit exceeds the maximum amount of Membrane Integrity Failure Occurrences, all membrane modules within the membrane unit shall be replaced unless:

1) Seller can demonstrate, through lot traceability, that the Membrane Integrity Failure Occurrence is attributed to a specific lot of membrane modules within a previously defined range of consecutive serial numbers.

2) The lot size shall be established by the membrane module manufacturer but shall not be less than 25 modules.

3) The number of membrane modules that are accountable for the Membrane Integrity Failure Occurrences are “localized” to less than 10 percent of the membrane modules located on the membrane unit.

e. If it is demonstrated that the membrane integrity failure defect is attributed to a specific lot or localized, then all membrane modules that have had more than a single previous occurrence of repair shall be replaced, even though they may be located in another membrane unit or may not have exceeded the criteria for individual membrane module integrity failure.

f. If more than two (2) membrane units require complete replacement within a 12 month period, the Buyer shall retain the option to replace all remaining membrane modules.

g. After Final Acceptance, if a membrane module is determined to be non-conforming with respect to membrane integrity, the Seller will remedy in accordance with the requirements set forth in this section.

1) Non-conforming membrane modules may be returned to service under the conditions outlined in this section.

2) If within 60 days after the notification to the Seller it has become apparent to the Buyer that membrane modules are not able to meet the provisions of the warranty, the Buyer will provide the Seller with a breach of warranty claim.

J. Irreversible Flux Loss

1. Membrane modules or elements shall be considered to have non-conforming irreversible flux loss under the following condition.

Definition of “clean water” resistance: The temperature corrected membrane resistance is defined as the “clean water” membrane resistance, as indicated in the Proposal Pricing Form, taken at a minimum of one (1) hour after startup of the membrane unit after completion of the chemical cleaning process, and taken five (5) minutes after completion of the most recent backwash. The temperature correction shall be calculated at 20°C using a viscosity correction factor. The equations and units used to calculate “clean water: resistance are as follows:

$$R = \frac{\Delta P}{J\mu}$$

Where: R = Membrane Resistance (psid/gfdcp)
J = Membrane Flux (gfd)
μ = Viscosity of water (cp)
ΔP = Differential Pressure (psid)

a. Irreversible Flux loss will be stated to have occurred if the MF/UF Units are not able to obtain a minimum of a 30-day clean-in-place (CIP) intervals respectively for 3 consecutive CIP intervals when operated at or below the temperature adjusted membrane design capacity using backwash (MF/UF Units only) and chemical washing procedures and frequencies established and demonstrated for the particular system during the Performance Testing Period.

b. Prior to the end of the first year or operation, each unit will be tested for permeability.

1) Prior to the permeability test, a CIP will be performed.

a) Seller will be allowed to observe the automated CIP cycle.

b) Bid temperature corrected flux rate will be set for each cell prior to the permeability test.

c) The permeability test duration will be run for a minimum of 5 minutes.

2) If the permeability is not at least 95 percent of the baseline permeability established following a CIP performed after at least 30 days of initial operation at the design capacity, the modules will be considered to have non-conforming irreversible flux loss.

a) Note: H2OI determined a baseline permeability of 7 gfd/psi at 20 degC. Prior to the end of the first year of operation, each UF train will be tested to confirm post-CIP permeability restoration to at least this baseline. It is important to note that terminal permeability (the value at which the UF system is no longer able to make the rated design flow) is 1.5 gfd/psi which is derived from maximum instantaneous design flux divided by the maximum TMP. The baseline permeability of 7 gfd/psi is a very conservative value more than 4.5 times greater than the terminal permeability value.

2. In the event that the Seller does not believe that the feed water quality is similar to that defined as the design water quality in Section 46 61 34, Containerized Membrane Filtration System, then the Seller may seek relief from its warranty obligations hereunder to the extent that its failure to meet these obligations is caused by a change in the influent water quality that is outside the range of the design influent water quality parameters.

    a. However, relief shall require demonstration that there is a defensible water quality parameter and/or duration that is outside of the influent water quality range that caused the warranty violation.

3. Should the Buyer and the Seller fail to agree on the cause of the warranty violation that is related to influent water quality, the matter shall be sent to binding arbitration.

    a. The Buyer and the Seller shall jointly select an arbitration panel consisting of water treatment professionals appointed by each party.

    b. The panel will consist of two members of each party or other mutually agreed upon number.

    c. The panel will then select 1 additional member as mutually agreed upon.

4. The Buyer recognizes that to remedy warranty provisions for irreversible flux loss, the Seller may modify operational protocols.

    a. Seller recognizes that changes to the operational protocols must be acceptable to the Buyer.

    b. The Buyer recognizes that the changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

        1) That the specified design parameters (e.g., production capacity, water quality, system recovery and CIP interval) are obtained.

        2) That the change in operational parameters and protocols (e.g., backwash, Maintenance Clean or CIP) will not represent an increase in the operational or membrane replacement cost to the Buyer.

c. If more than two units require membrane replacement at any time within Membrane Module Warranty Period for irreversible flux loss, the Buyer shall retain the option to replace all remaining membrane modules using the applicable membrane module price.

PART 2 -- PRODUCTS – (NOT USED)

PART 3 -- EXECUTION – (NOT USED)

PART 4 -- SUPPLEMENTAL INFORMATION

4.01 MEMBRANE LIMITS

Normal Operation

Transmembrane Pressure	-3 bar to + 3 bar (-43.5 psi to + 43.5 psi)
pH	1 to 10
Temperature	0 to 40 degrees C. Consult Pall before using any water treatment polymers

Membrane Cleaning (Includes CIP/MC Processes)

The following values are listed as maximum values that would potentially void the module warranty. Typical CIP and EFM values should be provided by Seller.

Temperature	40 degrees C. maximum
Sodium Hypochlorite	5,000 mg/L maximum
NaOH	20 g/L maximum
Citric Acid	100 g/L maximum

Membrane Storage

Store modules between 1 and 40 degrees C. Do Not Freeze.

Short Term Storage: If not in use, flush daily with up to 100 mg/L of free available chlorine.

Long Term Storage: First perform a Clean in Place, store wet, completely filled with 50-mg/L sodium hypochlorite solution. according to seller requirements.

END OF SECTION

SECTION 01 74 10 - TESTING AND DISINFECTION OF CONCRETE AND STEEL WATER STRUCTURES

PART 1 - GENERAL

1.1 THE SUMMARY

A. The Contractor shall test and disinfect concrete and steel hydraulic structures in accordance with the Contract Documents.

B. The Contractor shall be responsible for obtaining permits for discharging excess testing and disinfection water and dechlorination of such water if required to satisfy permit limit.

1.2 Contractor SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submittals shall include:

1. A testing plan and schedule, including methods for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval.

2. Name of certified bacteriological testing laboratory.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Temporary valves, bulkheads, and other water control equipment and choice of disinfectant shall be as determined by the Contractor. No materials shall be used which would be injurious to the Work or future storage of potable water.

B. Chlorine for disinfection may be in the form of sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

1. Sodium and calcium hypochlorite shall be in accordance with ANSI/AWWA B300-Hypochlorites.

C. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting will be furnished by the Owner; however, the Contractor shall convey the water from the Owner-designated source to the points of use.

B. All hydraulic structures and appurtenant pressure piping shall be tested; those for potable water shall also be disinfected by chlorination. The chlorinating and testing operations shall be performed in the presence of the Engineer.

C. In the case of a reservoir or tank, testing and disinfecting operations shall be combined.

D. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the Work is accepted by the Owner. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner. Results of the bacteriological testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

E. Protective coating on the interior of steel reservoirs shall be applied before the combined testing and disinfecting operations.

F. Release of water from structures after testing and disinfecting have been completed shall comply with federal, state, and local regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. Prior to both testing and disinfecting, hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. Water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the structure or otherwise removed.

3.3 TESTING OF STEEL STRUCTURES

A. General: The test shall consist of filling the structure with water to the maximum operating water surface elevation and observing for visible leakage over a period of time.

B. Evaluation and Repairs: After the structure has been filled, record the water surface level in the structure from the level indicating transmitters (LITs) to the nearest hundredth of a foot. Monitor the water surface level in the structure for 7 days. After the tank has been filled for 7 days, outside surfaces shall be inspected for visible leakage. Leakage, as evidenced by liquid droplets, flowing water, or rusty stains, shall be repaired. The tank will not be accepted if any leakage as defined above is visible. Repaired tanks shall be retested, and if acceptable results are obtained, disinfection may proceed. Visible leak tests shall be performed during a period of dry weather. If precipitation occurs during the 7-day leak test, the test shall continue for an additional 7 days after the last precipitation event.

3.4 TESTING OF CONCRETE STRUCTURES

A. General: Testing shall be performed prior to backfilling. Testing shall not be performed sooner than 14 days after all portions of structure walls have been completed. The following structures shall be tested.

1. Solids Handling Pump Station (Area 50)

2. Solids Handling Basins (Area 60)

3. Clarified Backwash Pump Station (Area 70)

B. Leakage Test and Repairs: After the structure has been filled, the leakage test shall be performed as follows:

1. The structure shall be filled to the maximum operating water level indicated on the Drawings, or if not indicated or if the level will be controlled by a weir, fill the structure to the weir level or to the overflow elevation, whichever is higher.

    a. Each of the three solids handling basins shall be hydrostatically tested separately. Water used for testing one basin may be pumped to adjacent basins for testing.

2. Once full, record the water surface level to the nearest hundredth of a foot with the installed level indicating transmitter (LIT). For the solids handling basins, monitor the adjacent along the exposed walls for damp spots in the soil, dripping or other signs of leakage.

3. Measure and record initial water level readings at two locations that are approximately 180 degrees apart if the structure is circular or at opposite ends of the structure if the structure is rectangular.

4. Construct evaporation/precipitation devices as follows. A clear plastic calibrated open top container greater than 18-inches in diameter and in depth shall be partly filled with water, floated in the structure, and held in position at each measurement location but away from structure walls and items passing overhead such as beams or pipes. Measure the depth of water in the device.

5. Record the structure water levels and depths of water in the evaporation/precipitation devices at 24-hour intervals for a 7-day test period.

6. Each daily change in water surface elevation at each measurement point shall be adjusted by subtracting the change in water depth in the corresponding evaporation/precipitation device.

7. Acceptance Criteria: Both criteria apply.

    a. Allowable leakage

        1) Unlined concrete structures will pass the test if the water loss at the end of 7-days, as determined by averaging adjusted results at the two measurement locations, is equal to or less than 0.20 percent of the structure volume. Structures with multiple cells shall have the cells tested and evaluated individually.

        2) Lined concrete structures will pass the test if the water loss/gain at the end of 7-days equals that lost/gained due to evaporation/precipitation.

    b. No visible leakage appears during the 7-day test.

8. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before starting a new 7-day test period.

9. If the structure fails the test, the Contractor may at its option repeat the test or empty the structure as acceptable to the Engineer and examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage. Cracks shall be repaired in accordance with Section 03 01 00 – Maintenance of Concrete.

10. Following these operations, the Contractor shall again test the structure. The structure will not be accepted until the water loss leakage test is passed and all visible leakage repaired. In the case of a reservoir, the retesting shall again be combined with disinfection, exclusive of the spraying operation.

3.5 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested in accordance with Section 33 05 05 – Pressure Pipe Testing and Disinfection.

3.6 DISINFECTION OF STRUCTURES AND APPURTENANT PIPELINES

A. Structures which store or convey potable water shall be disinfected by chlorination in accordance with the requirements of ANSI/AWWA C652 - Disinfection of Water Storage Facilities, using a combination of chlorination Methods 2 and 3 as modified herein, except that filter basins shall be disinfected in accordance with the requirements of ANSI/AWWA C653 - Disinfection of Water Treatment Plants.

B. Chlorination: A strong chlorine solution of approximately 200 mg/L shall be sprayed on all interior surfaces of the structure. Following this, the structure shall be partially filled with water to a depth of approximately one-foot. If the structure has a hopper bottom, fill it one-foot over the top of the hopper. During the partial filling operation, a chlorine-water mixture shall be injected by means of a solution-feed chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflowing water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/L upon completion of the partial filling operation. Precautions shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the pipe with the heavily chlorinated water.

C. Retention Period: Chlorinated water shall be retained in the partially filled structure and appurtenant piping for at least 24 hours. Each valve shall be operated at least once from closed to full open to closed while the lines are filled with the heavily chlorinated water. After the chlorine-treated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/L. If testing does not demonstrate a residual of 25 mg/L or greater, the disinfection procedure above shall be repeated.

D. Final Filling of Structure: After the free chlorine residual has been verified to satisfy the 25 mg/L requirement, the water level in the structure shall be raised to its final elevation by addition of potable water. Some heavily-chlorinated water shall be treated and released, if necessary, before final filling with potable water, such that the free chlorine residual after filling will be between 1 and 2 mg/L. After the structure has have been filled, the strength of the chlorinated water shall be determined. If the free chlorine residual is less than 1 mg/L, an additional dosage of chlorine shall be applied to the water. If the free chlorine residual is greater than 2 mg/L, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period.

3.7 BACTERIOLOGICAL SAMPLING AND TESTING

A. Disinfected water treatment and storage facilities shall be sampled and tested by a certified bacteriological laboratory.

3.8 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

END OF SECTION

SECTION 01 75 00 – EQUIPMENT TESTING AND PLANT STARTUP

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Plant startup is a prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times. Testing and startup shall be completed during Phase 1 before the Contractor can move onto Phase 2.

B. Conduct all test, check out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the Engineer prior to requesting Substantial Completion from the Engineer. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup

C. Startup of a treatment plant is a highly complex operation requiring the combined expertise of the Contractor, Subcontractors, Membrane System Supplier, Equipment Suppliers, the Engineer, and the Owner. The Contractor shall be responsible for coordinating all parties for a successful startup: the Engineer and Owner will be available for technical and operational advice prior to and during startup.

D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.

E. Temporary facilities may be necessary. If so, Contractor shall design, provide, operate, and later decommission them.

F. During startup, product water will be recycled using a clean water loop.

1.2 DEFINITIONS

A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Startup includes pre-commissioning and commissioning activities, manufacturer’s services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities.

B. Pre-commissioning is the systematic demonstration through testing and extended operation that major equipment and auxiliary systems, including related components, sub-systems, and systems operate properly and consistent with their intended function. Pre-commissioning involves balancing, adjustments, calibration, loop checks, and loop validation. Pre-commissioning shall simulate shutdown conditions, failure conditions, power fail and restart, bypass conditions, and failure resets. Pre-commissioning will not be considered complete until successful results and documentation of tests and manufacturer’s certifications required by the Contract Documents are submitted and accepted by the Engineer. Pre-commissioning of all portions of the Work shall be successfully completed prior to starting Commissioning.

C. Commissioning is the verification that the complete Work functions on an extended basis in full conformance with the Contract requirements.

1.3 SUBMITTALS

A. Schedule: The schedule for startup shall be submitted under Section 01 32 14 – Barchart Construction Schedule.

B. Startup Plan: Not less than 60 Days prior to startup, Contractor to submit for review a detailed Startup Plan. The Contractor shall revise the Plan as necessary based on review comments. The Plan shall include:

1. Schedules for manufacturers' equipment certifications

2. Schedules for submitting final Technical Manuals,

3. Schedule for training the Owner's personnel,

4. Description of temporary facilities and schedule for installation and decommissioning them

5. List of Owner and Contractor-furnished supplies

6. Detailed schedule of operations to achieve successful pre-commissioning and commissioning.

7. Checklists and data forms for each item of equipment

8. Address coordination with the Owner's staff and define roles and responsibilities for the Contractor, Engineer, and Owner.

9. Designate a representative of the Contractor who has the authority to act in matters relating to startup and has experience in testing Microfiltration Membrane Systems, Onsite Sodium Hypochlorite Generation Systems and pumps. The Plan shall also designate the roles and responsibilities of any Subcontractors, the membrane system supplier, and any other party that may be involved in startup activities.

10. Safety, startup, and testing procedures and proposed inspection and certification forms and records.

11. Interconnection of new to existing facilities

    a. Date and time frame of proposed shutdown or interconnection, including sequence of events and activities to be conducted.

    b. A detailed description of sequences and activities for the planned shutdown and interconnection.

    c. Staff, equipment, and materials that will be at the Site before commencing the shutdown.

    d. Other provisions so that interconnection, testing, and startup will be completed within the planned time.

12. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment. Schedule and plan shall indicate source of water, testing and disinfection sequence, disinfection procedures, and the disposal of the water following disinfection.

    a. Refer to Section 01 74 10 – Testing and Disinfection of Concrete and Steel Water Structures, and

    b. Refer to Section 33 05 05 – Pressure Pipe Testing and Disinfection

C. System Outage Requests: Request for shutdown of existing systems as necessary to test or start up new facilities. Refer to 01 10 00 - Summary of Work for allowable interruptions and minimum recover between interruptions..

D. Records and Documentation

1. Where required by the specifications, submit equipment installation certifications under those Sections.

2. Records of startup as indicated below.

E. NSF 60 certifications for treatment chemicals.

1.4 REFERENCE SPECIFICATIONS

A. NSF / ANSI 60: Drinking Water Treatment Chemicals - Health Effects

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 MALFUNCTIONS

A. During the extended operational demonstrations, all components, subsystems, systems, and equipment must properly run continuously 24 hours per day at rates indicated by the Engineer throughout the test period. Unless indicated otherwise, if any item fails or malfunctions during the test, the item shall be repaired and the test restarted at time zero with no credit given for the operating time before the failure or malfunction. Malfunctions satisfying all 3 of the following conditions will allow the demonstration period to resume at the elapsed time when the malfunction started:

1. Malfunction did not cause any interruption of the continuous operation of any other components, subsystems, systems, and equipment.

2. Malfunction was corrected without causing or requiring any components, subsystems, systems, and equipment to cease operations.

3. Malfunction was corrected within one hour of the time the malfunction was detected (the one hour period includes the time required to locate the cause of the malfunction, beginning upon Contractor’s notification from the Engineer that a malfunction has occurred and ending when the item is corrected and the system is successfully placed back into operation).

B. The Contractor shall arrange for manufacturer's representatives to visit the Site as often as necessary to correct malfunctions.

3.2 PREREQUISITES

A. Pre-commissioning and commissioning activities shall be scheduled according to Section 01 32 14 – Barchart Construction Schedule. The 7 Day demonstrations and the 8 Day demonstration shall start prior to midday on a Monday, Tuesday, or Wednesday. Testing periods shall not include holidays, based on the Owner's calendar.

B. The following shall be completed before pre-commissioning begins.

1. All Technical Manual information required by the Contract Documents has been submitted.

2. Safety equipment, emergency shower and eyewash units, fire extinguishers, gas detectors, protective guards and shields, emergency repair kits, safety chains, handrails, gratings, safety signs, and valve and piping identification required by the Contract Documents are provided. Devices and equipment shall be fully functional, adjusted, and tested.

3. Verification of completion of each Definable Feature of Work identified in the Contract Documents.

4. Manufacturer's certifications of proper installation have been accepted.

5. Completion and acceptance of all inspections and test that are required during the construction phase.

6. Leakage tests, electrical tests, and adjustments have been completed.

7. Disinfection, flushing, and testing of potable water pipelines, concrete and steel water structures in accordance with Specification Sections 01 74 10 – Testing and Disinfection of Concrete and Steel Water Structures and 33 05 05 – Pressure Pipe Testing and Disinfection.

8. The Engineer has approved the Startup Plan.

9. Temporary facilities are functional, adjusted, and ready for use.

10. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.

11. Pressure switches, flow switches, timing relays, level switches, vibration switches, temperature switches, RTD monitors, pressure regulating valves, and other control devices to the settings determined by the Engineer or the equipment manufacturer have been adjusted for accuracy.

12. Individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls have been verified.

3.3 GENERAL

A. Supplies

1. The Contractor shall furnish and install the following:

a. Chemicals

1) Supply NSF 60 certified chemicals of the following quantities for bulk chemical fills.

a) 1, 400 gallon bulk delivery of Aluminum Chlorohydrate (ACH) to be stored in the ACH tank. Provide by bulk chemical truck and install in Owner's tank.

b) 1, 400 gallon bulk delivery of Sodium Hydroxide (SDH) to be stored in the Sodium Hydroxide Storage Tank. Provide by bulk chemical truck and install in Owner's tank.

c) 1, 55 gallon delivery of Calcium Thiosulfate.

d) 1, 330 gallon tote delivery of Citric Acid.

2) At least one pallet of 40lb salt bags. The number of bags is estimated to be 56.

b. Fuel

c. Oil and grease

d. Other necessary materials not listed for the Owner to furnish

2. The Owner will furnish:

a. Water

b. Power

B. Startup Records: The Contractor shall maintain the following during testing and startup and submit originals to Engineer:

1. Lubrication and service records for each mechanical and electrical equipment item

2. Hours of daily operation for each mechanical and electrical equipment item

3. Equipment alignment and vibration measurement records

4. Logs of electrical measurements and tests

5. Instrumentation calibration and testing logs

6. Testing and validation of SCADA inputs, outputs, logic functions, status indications, and alarms

7. Factory and field equipment settings

8. Log of problems encountered and remedial action taken

9. Other records, logs, and checklists as required by the Contract Documents

3.4 PRE-COMMISSIONING

A. After individual equipment items and subsystems have been tested and certified as required by the Technical Specifications, tests of systems comprised of single or multiple equipment items with appurtenant equipment and instruments and controls shall be conducted. Items of equipment shall be tested as part of a system to the maximum extent possible.

B. Subject to the malfunction criteria above, each system shall be demonstrated for a continuous, 7 Day, 24 hour/day period. If any system malfunctions, the item or equipment shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.

C. The Contractor shall demonstrate the manual and automatic modes of operation to verify proper control sequences, software interlocks, proper operation of software logic and controllers, etc. System testing shall include the use of water or other process media, as applicable, to simulate the actual conditions of operation.

D. Systems testing activities shall follow the detailed procedures and checklists in the Testing and Startup Plan. Completion of systems shall be documented by a report.

E. The Contractor shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.

F. Furnish the Engineer at least 10 Days written notice confirming the start of pre-commissioning. The Engineer or Owner's staff will observe pre-commissioning.

G. Pre-Commissioning Testing: The Contractor shall:

1. Perform checkout and function testing as specified in the individual equipment sections and the Contract.

2. Functionally test mechanical and electrical equipment and instrument and controls systems for proper operation after installation testing tasks have been completed.

3. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer’s representative.

4. Demonstrate the equipment is effectively communicating with each other.

H. Certification of Proper Installation

1. At completion of Function Testing, the Contractor shall furnish comprehensive certified test record documentation, prepare and signed by manufacturer's authorized representative, by the electrical and/or instrumentation subcontractor, certifying the following for all components, devices, equipment, subsystems, systems, facilities, controls, and processes:

    a. Has been properly installed, adjusted, aligned, and lubricated

    b. Is free of stresses imposed by connecting piping or anchor bolts

    c. Is suitable for satisfactory full-time operation under full load conditions

    d. Operates within the allowable limits for vibration

    e. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been fully configured and tested and is properly operating

    f. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.

    g. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning. Note: this is limited to local controls only (i.e. – communicating with the PLC but independent of the PLC programming).

    h. A Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by the equipment manufacturer's representative.

    i. Other sign-off sheets will be furnished by the Engineer prior to initiation of Functional Testing.

    j. The certified test records shall include documentation of all pre-commissioning and commissioning activities and tests, studies, compliance certificates, and other records required by the specifications.

3.5 COMMISSIONING

A. The Contractor shall start up the plant and operate it without malfunction for a continuous 8 Day, 24 hour/day period. The Engineer will determine the operational parameters.

B. Upon approval of the Engineer's commissioning testing and pre-start-up activities, the Contractor shall prepare the site for and perform facility start-up testing that includes the following:

1. The Contractor shall be responsible for installing temporary piping, valves, pumps, and other appurtenances (including electrical) that will be required for the start-up and commissioning of the facility. The detailed plan will be developed prior to construction. Temporary facilities shall be removed completed at the end of the project.

2. Process area start-ups: where possible and beneficial to reduce complexity and risk of complete facility testing, start-up individual process areas comprised of multiple interdependent systems. Process area test flows will be limited by upstream, and downstream process constraints (i.e., tank and basin volumes) and/or localized recirculation capabilities

3. Defects that appear shall be promptly corrected. Time lost for wiring corrections, control point settings, or other reasons that interrupt the test may, at the judgement of the Engineer, be cause for extending the demonstration an equal amount of time.

4. Commissioning shall not begin until leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, disinfection, and system tests have been completed to the satisfaction of the Engineer.

5. System testing with water – no treatment: test entire facility with recirculating water supply at the design flow for the largest single process or system train to ensure proper complete facility (devices, components, equipment, and controls) hydraulic performance.

6. During commissioning, the Contractor shall lubricate and maintain equipment in accordance with the manufacturers' recommendations.

7. Perform to the extent possible control testing and control loop tuning during system testing with water, control testing, interlock and permissive testing, etc.

8. Systems testing activities shall follow the detailed procedures and checklists in the Startup and Commissioning Plan. Completion of systems shall be documented by a final report and submitted to the Owner.

9. The Contractor shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.

C. Upon completion of start-up testing, the Contractor shall perform entire facility start-up resulting in treatment of raw water delivered from the raw water conveyance system. The Contractor will also complete remaining control loop tuning and interlock permissive testing during this phase of start-up.

D. The Contractor shall conduct remaining equipment, subsystem, and system performance tests as specified that could not be performed during the commissioning phase due to inter system and/or treatment process dependencies.

E. The Owner will furnish certified treatment plant operators during the startup period to comply with Washington Department of Health requirements. Certified operators will be under the direct supervision of and be responsible to the Contractor. The Contractor shall furnish continuous staffing at the facility for the commissioning period.

END OF SECTION

SECTION 01 77 00 – PROJECT CLOSEOUT

PART 1 -- GENERAL

1.1 FINAL CLEANUP

A. The Contractor shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the Work by the Owner will be withheld until the Contractor has satisfactorily performed the final cleanup of the Site.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

1.3 CLOSEOUT TIMETABLE

A. The Contractor shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the Owner, the Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.4 TECHNICAL MANUAL SUBMITTAL

A. The Contractor's attention is directed to the condition that one percent of the Contract Price will be retained from any monies due the Contractor as progress payments, if at the 75 percent construction completion point, the approved Technical Manual complying with Section 01 33 00 – Submittal Procedures has not been submitted. The aforementioned amount will be retained by the Owner as the agreed, estimated value of the approved Technical Manual. Any such retention of money for failure to submit the approved Technical Manual on or before the 75 percent construction completion point shall be in addition to the retention of any payments due to the Contractor under Article 15 of the General Conditions.

1.5 FINAL SUBMITTALS

A. The Contractor, prior to requesting final payment, shall obtain and submit the following items to the Engineer for transmittal to the Owner:

1. Written guarantees, where required.

2. Technical Manuals and instructions.

3. New permanent cylinders and key blanks for all locks.

4. Maintenance stock items; spare parts; special tools.

5. Completed record drawings.

6. Bonds for roofing, maintenance, etc., as required.

7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

B. Evidence of payment and release of liens in accordance with conditions of the Contract.

C. Consent of Surety to final payment.

D. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

1.6 MAINTENANCE AND GUARANTEE

A. The Contractor shall comply with the maintenance and guarantee requirements contained in Article 15 of the General Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the Contractor shall have obtained a statement in writing from the affected private owner or public agency releasing the Owner from further responsibility in connection with such repair or resurfacing.

C. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and its surety shall be liable to the Owner for the cost thereof.

1.7 BOND

A. The Contractor shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Article 15 of the General Conditions.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 79 00 - OWNER STAFF TRAINING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to train Owner's personnel on the equipment, products, and systems furnished under this Contract. Owner training is a prerequisite to satisfactory completion of the Contract requirements and shall be completed within the Contract Time.

B. Training for the membrane system is described in Section 01 73 00 – Training of Operations and Maintenance Personnel. This Section shall be for the balance of equipment.

C. The minimum onsite training requirements for various plant components are described in various sections of the specifications.

D. Except where otherwise indicated, all costs for training shall be the responsibility of the Contractor.

1.2 SUBMITTALS

A. Training Schedule: Schedule for training the Owner's personnel shall be submitted with the detailed Testing and Startup Plan required by Section 01 75 00 – Equipment Testing and Plant Startup.

B. Resumes of instructors.

C. The training lesson plan and materials shall be submitted to the Engineer for review at no later than the progress payments for 50 percent of the Contract Price.

D. Approved operation and maintenance manuals shall be available at least 30 days prior to the scheduled date for the individual training session.

E. Training classes shall be scheduled a minimum of four (4) weeks in advance of the date of the first class to allow Owner staffing arrangements to take place. The Contractor shall schedule training classes within the period 8:00 a.m. to 5:00 p.m. Monday through Friday.

F. Training classes shall be organized in conjunction with the Startup Systems, as defined in Section 01 75 00 – Equipment Testing and Plant Startup. Each training class shall consist of a classroom portion and a field tour portion. Each training class shall include:

1. Safety to be conducted by the plant safety officer.

2. Overview of the startup system, conducted by the Engineer.

3. Training on each item of equipment within the startup system, conducted by the Equipment Manufacturer's representative.

4. Training on the mechanical piping system within the startup system, conducted by the Contractor's mechanical superintendent.

5. Training on the power distribution system within the startup system, conducted by the Contractor's electrical superintendent.

6. Training on the instrumentation and control systems within the startup system, conducted by the Contractor's I&C System Supplier.

7. Training on the SCADA control system within the startup system, conducted by the Contractor's I&C System Supplier.

8. Training on the Membrane Filtration system within the startup system, conducted by the Membrane supplier.

G. Class Agenda: A class agenda shall be prepared by the Contractor and submitted to the Engineer with the training schedule. The agenda shall include a listing of subjects to be discussed, time estimated for each subject, a list of documentation to be used and provided to support training, the proposed route of the field tours, and the instructor(s) name and qualifications. Agendas shall include an allocation of time for all components of the training session, including time for Owner staff to ask questions and discuss the subject matter. The Owner may request that particular subjects are emphasized and the agenda shall be adjusted to accommodate these requests. Copies of the agenda shall be distributed to each student at the beginning of each training class.

H. Within ten (10) days after the completion of each training session, the Contractor shall submit the following:

1. A sign-in sheet of all personnel that attended the training session, including the instructor and any witnesses.

2. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

I. All information provided in the class, in PDF or Microsoft compatible formats.

1.3 INSTRUCTOR QUALIFICATIONS

A. Instructors shall be completely knowledgeable in the products and systems for which they are providing training, and shall be experienced in conducting classes. Sales representatives are not considered qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.

B. Instructor shall have at least two years of experience in providing training certified by the Manufacturer.

C. If, in the opinion of the Owner, the Instructor did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor at the Contractor's expense.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this Contract.

2.2 TRAINING AIDS

A. Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, or other means to effectively increase the transfer of knowledge. The instructor conducting the training shall furnish all such equipment (televisions, projectors, screens easels, etc.), models, and charts for each class. It shall be the responsibility of the instructor to confirm in advance that the class room will be appropriate for the types of audio-visual equipment to be employed.

2.3 LOCATION

A. Training sessions shall take place at location specified by the Owner, except for field training on the actual equipment which shall occur at the Project Site.

2.4 FORMAT AND CONTENT

A. Use approved Operation and Maintenance (O&M) Manual(s) as the basis for instruction. Review contents of manuals with personnel in detail to explain all aspects of operation and maintenance. Prepare and insert additional data in O&M Manuals when need for such data becomes apparent during instruction. Promotional information will not be accepted. Power Point, handouts and hands-on instruction are encouraged. Simply reading from the O&M manual is not an acceptable training method.

B. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization

    a. Review catalog, parts lists, drawings, etc., which have been previously provided for the Owner's files and operation and maintenance manuals.

    b. Inspection on how the equipment has been installed. Demonstrate the operation of the unit and describe how all parts of the equipment meet the requirement of the Specifications.

    c. Answer questions.

2. Safety

    a. Using material previously provided, review safety features of the equipment.

    b. Discuss proper precautions when working around equipment.

3. Operation

a. Using material previously provided, review reference literature.

b. Explain all modes of operation (including emergency).

c. Check out Owner's personnel on proper use of the equipment.

4. Preventive Maintenance

a. Using material previously provided, review preventive maintenance (PM) lists including:

1) Reference material.

2) Daily, weekly, monthly, quarterly, semiannual, and annual PM activities.

b. Demonstrate how to perform Preventive Maintenance procedures.

c. Demonstrate to the Owner's personnel what to look for as indicators of potential equipment problems.

5. Corrective Maintenance

a. Identify possible problems.

b. Demonstrate how to perform repairs. Point out special problems.

c. Open up equipment and demonstrate O&M procedures, where practical.

6. Parts

a. Demonstrate the use of previously provided parts list and order parts.

b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives

a. Identify local vendors where to order parts: name, address, telephone.

b. Service problems:

1) Identify contacts local contacts.

2) Identify emergency contacts.

8. Operation and Maintenance Manuals

a. Review any other material submitted.

b. Update material, as required.

PART 3 -- EXECUTION

3.1 GENERAL

A. The objective of the training included under this Section shall be to convey the knowledge needed by the Owner operations, maintenance, and engineering staff to safely operate, maintain, and repair the equipment and systems furnished under this Contract.

B. Owner personnel who will participate in this training have existing full-time work assignments and this training is an additional assigned work task. Owner's staff work schedules regularly shift, as the plant is operated on an around-the-clock basis.

C. Training shall be tailored to suit the skills and job classifications of the personnel attending the classes e.g., plant manager, plant operator, maintenance technical, electrician, etc.

D. Minimum onsite training requirements for plant components are described in various sections of the Specifications. For the purpose of the times given in individual Specification sections, a workday is defined as an eight (8) hour day at the site, excluding travel time.

E. Training shall be scheduled as a separate trip from equipment inspection, startup, and field adjustment. Training shall not be done until the manufacturer certifies that the equipment is operable as specified.

F. Satisfactorily complete functional testing before beginning training sessions. Training will be conducted prior to process startup of associated systems or equipment.

G. Specific Training Objectives: The training shall include a review of the equipment and drives, including internal parts, as prepared at the factory. The training shall include safety, removal, inspection, cleaning, operation and maintenance of the equipment such as startup, normal operation and shutdown procedures, step-by-step troubleshooting procedures with all necessary test equipment, and emergency or abnormal operation procedures. Training shall include preventive maintenance and long-term maintenance procedures, special tools necessary, and a discussion of recommended spare parts.

3.2 TRAINING CLASSES

A. Number of Classes on Each Subject: A minimum of two (2) classes on identical subject matter shall be conducted, unless otherwise indicated. The purpose of having two (2) classes on each subject is to accommodate the attendance of as many Owner personnel working different shifts as possible.

B. A maximum of one (1) class per day shall be held on consecutive days unless otherwise approved by the Owner. Multiple classes may be scheduled if the class duration is shorter than four (4) hours. Times shall be scheduled at the discretion of the Owner.

C. Class Length: Each class shall be subdivided into two (2) to six (6) hour modules, or as appropriate for the subject matter being discussed.

D. Number of Students: It is estimated that five (5) to ten (10) persons will attend each training class. The Owner will determine the actual number of students. Provide training materials for all attendees.

E. Cancellation of Classes: If a class must be canceled because the equipment is not ready for operation, etc. the Contractor shall notify the Owner at least one (1) week in advance. The Contractor shall coordinate with the Owner to reschedule the training.

3.3 TRAINING AIDS

A. Training Aids: Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, etc. to increase the transfer of knowledge. The Contractor shall provide all such equipment (televisions, DVD player, projectors, screens, easels, models, charts, etc.) for each class. It shall be the responsibility of the Contractor to confirm in advance that the training room set-up will be appropriate for the types of audiovisual equipment to be employed.

B. Classroom Documentation: If training is being completed on equipment, systems, or products for which a Technical Manual is required, the draft Technical Manual shall have been returned by the Engineer with a status of “No Exceptions Taken” or “Make Corrections Noted” before the training class is scheduled. The approved Technical Manual shall be used during the classroom instruction. Supplemental documentation handouts shall be provided by the organization conducting the training as required to the support instruction.

3.4 DOCUMENTATION OF TRAINING

A. The Contractor shall videotape the entire detailed training course in proper operation and maintenance and provide the video in an online digital format or DVD format. The video shall be organized by each segment of the training session and be presented in a table of contents style with selectable segments of the session. The videotape shall become the exclusive property of the Owner. The Owner reserves the right to videotape, photograph, audio record, and otherwise document any or all training classes provided under this WORK.

B. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum, classroom equipment training for operations personnel will include:

a. Identify and discuss safety items and procedures.

b. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.

c. Purpose and plant function of the equipment.

d. A working knowledge of the operating theory of the equipment.

e. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.

f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:

a. Identify and review safety items and perform safety procedures.

b. Identify location of equipment and review the purpose.

c. Identifying piping and flow options.

d. Identifying valves and their purpose.

e. Identifying instrumentation.

f. Location of primary element.

g. Location of instrument readout.

h. Discuss purpose, basic operation, calibration, maintenance, troubleshooting, repair, and information interpretation.

i. Discuss, demonstrate, and perform standard operating procedures and round checks.

j. Discuss and perform the preventative maintenance activities.

k. Discuss and perform start-up and shutdown procedures.

l. Perform the required equipment exercise procedures.

m. Perform routine disassembly and assembly of equipment if applicable.

3. Classroom equipment training for the maintenance and repair personnel will include:

a. Safety procedures.

b. Theory of operation.

c. Description and function of equipment.

d. Start-up and shutdown procedures.

e. Normal and major repair procedures.

f. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

g. Routine and long-term calibration procedures.

h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

i. Hands-on equipment training for maintenance and repair personnel shall include:

1) Locate and identify equipment components.

2) Review the equipment function and theory of operation.

3) Review normal repair procedures.

4) Perform start-up and shutdown procedures.

5) Review and perform the safety procedures.

6) Perform Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

SECTION 01 10 00 – SUMMARY OF WORK

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Work to be performed under this Contract shall consist of furnishing plant, tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The Work shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the Work in good faith shall be provided by the Contractor as though originally so indicated, at no increase in cost to the Owner.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

1.03 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of this Contract comprises the construction of a new one million gallon per day water filtration plant which includes:

1. Modifications to the influent and effluent pipelines
2. Repurposing the existing Filtered Water Pump Station for use as a Membrane Feed Tank
3. Skid-mounted membrane equipment housed in a weather-resistant enclosure provided by the manufacturer
4. A pre-engineered metal building containing:
    a. Control room and lab
    b. Bathroom
    c. Chemical storage and feed equipment
5. Retrofit of the existing water treatment plant for backwash clarification
6. Construction of a new Chlorine Contant Tank
7. Retrofit of the existing pond/basin for solids storage
8. An underground Clean-In-Place storage tank

B. The following is a list of additive bid alternates. These items may be included in the project if the District's budget is sufficient.

1. The covered canopy, which extends from the Chemical Building to the membrane treatment units

2. Standby power generator and automatic transfer switch

C. The Work is located at the Owner's water filtration plant, approximately 1/4-mile south of the intersection of Kid Ln. and Old Detour Rd. in the town of Carson, Washington.

1.04 CONTRACT METHOD

A. The Work hereunder will be constructed under a single lump sum contract.

1.05 WORK BY OTHERS

A. Where 2 or more contracts are being performed at one time on the same Site or adjacent land in such manner that work under one contract may interfere with work under another, the Owner will determine the sequence and order of the Work in either or both contracts. When the Site of one contract is the necessary or convenient means of access for performance of work under another, the Owner may grant privilege of access or other reasonable privilege to the contractor so desiring, to the extent, amount , and in manner and at time that the Owner may determine. No Owner determination of method or time or sequence or order of the work or access privilege shall be the basis for a claim for delay or damage except under provisions of the General Conditions for temporary suspensions of the work. The Contractor shall conduct its operations so as to cause a minimum of interference with the work of such other contractors and shall cooperate fully with such contractors to allow continued safe access to their respective portions of the Site, as required to perform work under their respective contracts.

B. Interference With Work On Utilities**:** The Contractor shall cooperate fully with all utility forces of the Owner or forces of other public or private agencies engaged in the relocation, altering, or otherwise rearranging of any facilities which interfere with the progress of the Work, and shall schedule the Work so as to minimize interference with said relocation, altering, or other rearranging of facilities.

1.06 WORK SEQUENCE

A. The Contractor's attention is directed to the fact that no interruption in the flow can be accommodated during high water demand, typically July 15 through August 15. The Contractor shall so schedule its construction operations that no interference with the operation of the plant will occur during this critical period.

B. Access to the site is limited to the hours of 7:00 am to 5:00 pm.

1.07 CONTRACTOR USE OF SITE

A. The Contractor's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

1.08 OUTAGE PLAN AND REQUESTS

A. Unless the Contract Documents indicate otherwise, the Contractor shall not remove from service, de-energize, or modify settings for any existing operating tank, pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the Engineer.

B. Where the Work requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the Contractor shall submit a detailed outage plan and schedule for the Engineer's approval a minimum of 2 weeks in advance of the time that such outage is planned.

C. A completed System Outage Request form (blank furnished by the Engineer) shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents.

D. The Engineer shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.

E. The Contractor shall provide written confirmation of the shutdown date and time 2 working days prior to the actual shutdown.

F. Reference Section 01 14 00 – Construction Constraints for allowable outage durations

1.09 OWNER USE OF THE SITE

A. The Owner may utilize all or part of the existing facilities during the entire period of construction for the conduct of the Owner's normal operations. The Contractor shall cooperate and coordinate with the Owner to facilitate the Owner's operations and to minimize interference with the Contractor's operations at the same time. In any event, the Owner shall be allowed access to the Site during the period of construction.

1.10 PROJECT MEETINGS

A. Preconstruction Conference

1. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the Contractor's Project Manager, its superintendent, and its subcontractors as the Contractor deems appropriate. Other attendees will be:

a. Engineer and the Resident Project Representative.

b. Representatives of Owner.

c. Governmental representatives as appropriate.

d. Others as requested by Contractor, Owner, or Engineer.

e. The Contractor shall bring the preconstruction conference submittals in accordance with Section 01 33 00 – Submittal Procedures.

2. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the Contractor prior to the meeting date. However, the Contractor should be prepared to discuss all of the items listed below.

    a. Status of Contractor's insurance and bonds.

    b. Contractor's tentative schedules.

    c. Transmittal, review, and distribution of Contractor's submittals.

    d. Processing applications for payment.

    e. Maintaining record documents.

    f. Critical work sequencing.

    g. Field decisions and Change Orders.

    h. Use of Site, office and storage areas, security, housekeeping, and Owner's needs.

    i. Major equipment deliveries and priorities.

    j. Contractor's assignments for safety and first aid.

    k. Daily Report Form which the Engineer will furnish.

    l. Submittal Transmittal Form which the Engineer will furnish.

    m. Tracking of long lead equipment and materials

3. The Engineer will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

4. The Contractor and its subcontractors should plan on the conference taking no less than 0.5 a working day. The preconstruction conference will cover the items listed in paragraphs 2 and 3, and a review of the Drawings and Specifications, in extensive detail, with the Engineer and the Owner.

B. Progress Meetings

1. The Engineer will schedule and hold regular on-Site progress meetings at least weekly and at other times as requested by Contractor or as required by progress of the Work. The Contractor, Engineer, and all subcontractors active on the Site shall attend each meeting. Contractor may at its discretion request attendance by representatives of its suppliers, manufacturers, and other subcontractors.

2. The Engineer will preside at the progress meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings is to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the Contractor shall present any issues that may impact its progress with a view to resolve these issues expeditiously.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 14 00– CONSTRUCTION CONSTRAINTS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Work shall be scheduled, sequenced, and performed in a manner which minimizes disruption to the public and to the operation and maintenance of existing facilities.

B. The Contractor shall incorporate the construction and schedule constraints of this Section in preparing the construction schedules required under Section 01 32 14 – Barchart Construction Schedule.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 32 14	Barchart Construction Schedule
01 50 10	Protection of Existing Facilities

1.03 EXISTING PLANT

A. The Work shall be executed while the existing water treatment plant is in operation. Operation of the existing plant shall not be jeopardized nor shall the efficiency of water treatment be reduced as a result of the execution of the Work.

B. Unless indicated otherwise, temporary pumping, piping, power, lighting, controls, instrumentation, alarms, security devices, and safety devices shall be provided by the Contractor whenever its activity or interruption due to its activity affects the existing facility.

C. The construction constraints in this Section do not include every item affecting the completion of the Work but are intended to describe the sequence of critical events necessary to minimize disruption to the ongoing treatment plant processes and to ensure compliance with Permit requirements. It shall be understood and agreed by the Contractor that the critical events described are not inclusive and that additional items of Work not included may be required to minimize disruption and ensure compliance. Deviation from or modification of these suggested sequences is permitted if techniques and methods known to the Contractor will result in reducing disruption to the facility operation and maintaining treatment efficiency, and if deviation is approved in advance by the Engineer.

1.04 OPERATION OF PLANT EQUIPMENT

A. Operational functions or shutdown of the existing plant required to facilitate Contractor's operation will be done by the Owner's personnel only.

B. The plant operation and maintenance personnel will cooperate in every way that is practical in order to facilitate Contractor's operation. However, certain shutdown and connections may only be permissible at times other than normal working hours such as nights or weekends. No additional payment will be made to the Contractor for any night, weekend, or holiday premium or overtime payments.

C. If it becomes necessary for the proper operation or maintenance of portions of the plant, the Owner may require the Contractor to reschedule an approved shutdown. The Contractor shall then reschedule its operations so there shall be no conflict with necessary operations or maintenance of the plant. The Contractor shall, within 2 Days, furnish the Engineer a revised outage request and a plan for rescheduling the shutdown in accordance with the requirements of the construction schedule.

1.05 OUTAGE REQUESTS

A. Modifications to existing facilities, the construction of new facilities, and the connection of new to existing facilities may require the temporary outage or bypass of existing treatment processes or facilities. In such cases, the Contractor shall coordinate Work with the Engineer as described below. The Contractor shall submit a detailed outage plan and time schedule for construction activities which will make it necessary to remove a tank, pipeline, channel, electrical circuit, equipment, structure, road, or other facilities from service.

B. The outage plans shall be submitted to the Engineer for acceptance a minimum of 2 weeks in advance of the time that such outages are required. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of this Section. The outage plan shall describe the Contractor's method for preventing bypassing of other treatment systems; the length of time required to complete the operation; any necessary temporary power, controls, instrumentation, or alarms required to maintain control, monitoring, and alarms for the treatment plant processes; and the manpower, plant, and equipment which the Contractor shall provide in order to ensure proper operation of associated treatment units. Costs for preparing and implementing the outage plans shall be the responsibility of the Contractor as part of the Work.

C. The Contractor shall not begin an alteration affecting existing facilities until specific written approval has been granted by the Engineer in each case.

D. The Engineer will coordinate the Contractor's planned procedure with the treatment facility personnel. The Engineer has the authority to modify any proposed shutdown procedures if such procedures would adversely impact the plant operations.

E. Reference Section 01 10 00 – Summary of Work for outage instructions.

F. The contractor shall also account for plant recovery time between interruptions. The acceptable duration of seasonal interruptions and minimum recovery time are summarized below:

Schedule	**Maximum Allowable Interruption**	**Minimum Recovery Between Interruptions**
June 15 – July 14	24 hours	48 hours
July 15 – August 15	prohibited	
August 16 – September 15	24 hours	48 hours
September 16 – November 15	48 hours	24 hours
November 16 – March 15	3 days	24 hours
March 16 – June 14	48 hours	24 hours

1.06 TEMPORARY CONNECTIONS

A. Making connections to existing facilities or other operations that interfere with the operation of the existing equipment shall be thoroughly planned in advance, and required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall be completed as quickly as possible and with as little delay as possible and shall proceed continuously (24 hours a day and seven days a week) if necessary to complete modifications and/or connections in the minimum time.

B. The cost of any temporary facilities and night, weekend, or holiday activity and overtime payments required during process interruptions shall be included in the Work.

C. Temporary facilities and piping shall be located to minimize interference with Contractor's construction facilities and Owner's operation and maintenance of the wastewater treatment plant. Unless otherwise indicated, each temporary pipeline shall be of the same size as its connection to the existing or permanent facility at the downstream end of the pipeline. Piping materials shall be suitable for the material being conveyed and be as required in the Contract Specifications.

D. When temporary electrical power, controls, instrumentation, or alarms are required for routine continuous operations of existing or new equipment, the Contractor shall provide the necessary equipment and appurtenances. Prior to installing said equipment and appurtenances, Contractor shall furnish a submittal on the proposed components and installation for Engineer's review and approval.

E. A plan showing the size and location of the temporary facilities and piping shall be submitted to the Engineer at the same time as the outage plan required under this Section. Costs for design, provision, operation, and removal of temporary facilities and piping shall be part of the Work.

1.07 CONSTRUCTION SEQUENCING

A. General: It is the Contractor's responsibility to coordinate and plan the construction activities to integrate each schedule constraint into performance of the overall Work.

B. Construction activities shall be scheduled and sequenced to ensure continuous operation of the existing treatment facilities. The Contractor's scheduling shall develop construction sequencing so that the Work will not adversely impact treatment. The Contractor shall be responsible for development of the construction sequencing. In implementing the construction sequencing, the Contractor shall maintain the existing facilities in service until new facilities are constructed and are operational to supplement the existing capacity. When new facilities are operational, the existing facilities may be taken out of service. The following general guidelines shall be used by the Contractor in planning the sequence of construction.

1. Safe working conditions for personnel shall be maintained during rehabilitation, modification, and demolition Work. The foregoing includes at least proper trench excavation, the provision of temporary equipment guards, supports, warning signs, walkways, covers over openings, handrailing, and protection of electrical equipment and power supply.

2. Temporary facilities shall be constructed in accordance with applicable codes and regulations to operate safely and properly.

3. Valves to be temporarily shut off during the Work shall be tagged as such and shall be wired shut with a crimped lead seal and padlocked. Shut off shall be supervised by facility staff.

4. Electrical and mechanical equipment shall be similarly shut down and locked out, tagged out.

C. Phase 1

1. Membrane container startup, acceptance testing, Owner approval, and Department of Health approvals must be achieved before proceeding to Phase 2.

2. The Phase 1 piping arrangement is indicated on the drawings and includes:

a. Installation of a coagulant dosing system in the existing raw water meter vault

b. A connection to the existing raw water pipeline which will route flow to the membrane system using gravity flow from Bear Creek, i.e, bypassing the Raw Water Pump Station.

c. Two vertically oriented blind flanges can be used to route filtered water back to the raw water pipeline during commissioning to recirculate during testing. The Contractor shall provide a tee, valve, and piping to route filtered water to the solids handling basin.

d. Reverse Flow piping shall be installed to send backwash waste to the existing Solids Handling Basin if the Contractor deems it constructible. If one or both Solids Handling Basin's cannot be constructed, the Contractor will be required to pump and treat backwash water which can be discharged to the stormwater flow spreader.

e. Constraints include:

1) The Contractor cannot make a direct connection to the existing Filtered Water Pump Station (new Raw Water Feed Tank) during Phase 1.

2) The Contractor cannot make a connection to the existing filtered water pipeline during Phase 1 unless an air-gap is provided.

3) The CIP Waste Storage Tank should be constructed, as well as the septic/drainfield, so that Clean-In-Place waste can be discharged properly.

4) The stormwater system flow spreader shall be installed.

5) The existing water treatment plant filters will need to be backwashed during construction; the Solids Handling Basin, or a portion thereof will need to remain in service. Alternatively, the Contractor can pump and treat backwash water and discharge it to the stormwater flow spreader.

3. Once Phase 1 is complete, the Contractor shall place the membrane system into full service so that:

a. Demolition of the existing filtration systems can be completed to accommodate conversion to backwash clarification.

b. The existing filtered water tank and pump station can be converted to the new Raw Water Pump Station.

1.08 PERMITS

A. The Contractor shall abide by the conditions of permits and shall obtain proof of satisfaction of conditions from issuers of permits prior to acceptance of the Work by the Owner.

B. Conditions affecting the Contractor are found in the following permits.

1. Building Permit – by Owner.

2. Skamania County Septic and Drainfield Permit – Submitted by Owner, finalized by Contractor.

a. Design has been submitted to the County and permit is good for 2 years from February, 2026

3. National Scenic Area – Clear and Grade Permit – By Owner.

4. Electrical, plumbing, HVAC and other trade permits as required – by Contractor.

5. NPDES permits for discharges of water used for startup, disinfection, or cleaning – by Contractor.

6. Erosion Control – by Contractor.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 00 - MEASUREMENT AND PAYMENT

PART 1 -- GENERAL

1.01 SUMMARY

A. Measurement is described under each bid item in this Section.

B. Payment for the various items on the Bidding Schedule, as further specified herein, shall include all compensation to be received by the Contractor for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work being described, as necessary to complete the various items of the work all in accordance with the requirements of the Contract Documents, including all appurtenances thereto and including all costs of compliance with the regulations of public agencies having jurisdiction, including safety and health requirements of the Occupational Safety and Health Administration of the U. S. Department of Labor (OSHA). No separate payment will be made for any item that is not specifically set forth in the Bidding Schedule, and all costs therefore shall be included in the prices named in the Bidding Schedule for the various appurtenant items of work.

C. Indirect costs, such as supervision and overheads, profit, the general conditions specified in the Contract, all shall be allocated to each bid item as applicable for work defined in the bid item. No separate payment will be made to the Contractor for these items.

1.02 BID ITEM MEASUREMENT AND PAYMENT

A. The Bidding Schedule is divided into numerous bid items whose definitions follow. Bid Item Nos. 1, Nos. 2, and represent the entire scope of work covered by the Contract Documents.

B. Bid Item No. #2, Trench Excavation Safety Systems (Lump Sum):
   1. As required by RCW 39.04.180, this bid item shall include all cost for work of providing adequate safety systems for trench excavation which exceed a depth of four feet to comply with the requirements of the Washington Industrial Safety and Health Act, Chapter 49.17 RCW.
   2. The costs of trench safety systems shall not be considered as incidental to any other contract item and any attempt to include the trench safety systems as an incidental cost is prohibited.
   3. Measurement will be in accordance with a reasonable apportionment of the work as established in the Schedule of Values.

C. Payment will be based on the percentage of completion of each item in the Schedule of Values.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 29 73 – SCHEDULE OF VALUES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. This Section defines the process whereby the Schedule of Values (lump sum price breakdown) shall be developed and incorporated into the Barchart Construction Schedule in accordance with the requirements of Section 01 32 14 – Barchart Construction Schedule.

B. Monthly progress payment amounts will be determined from the monthly progress updates of the Schedule activities.

C. Develop the Schedule of Values independent of but simultaneous with the development of the Schedule activities and logic.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 32 14	Barchart Construction Schedule
01 10 00	Summary of Work

1.03 PRELIMINARY SCHEDULE OF VALUES

A. Submit a preliminary Schedule of Values for the major components of the Work at the Preconstruction Conference in accordance with the requirements of Section 01 10 00 – Summary of Work.

B. At a minimum, submit proposed values for the following major Work components:

1. Mobilization: 5% percent of Contract Price;

2. The total value of electrical Work;

3. The total value of instrumentation and control Work;

4. The total value of protective coatings Work;

5. The total value of yard mechanical Work inclusive of excavation, pipe installation, testing and backfill of pipe, and all incidental Work associated with underground pipe installations;

6. The total value of mechanical Work:

   a. Exclusive of yard mechanical Work included in Item 5 above, but including piping, valves, equipment, tanks, and appurtenances at new and existing structures;

   b. Break down this total value into separate values for each new and existing structure constructed or modified as a part of the Work;

7. The total value of structural reinforced concrete Work:

a. Inclusive of excavation, dewatering, subgrade preparation, backfill, and incidental Work for new structures;

b. Break down this total value shall be broken down into separate values for each new structure constructed as a part of the Work;

c. Miscellaneous and minor concrete Work may be listed as one item in this breakdown;

8. The total value of metal buildings:

a. Inclusive of architectural Work, doors, windows and other incidental systems and features;

b. Break down, this total value shall be broken down into separate values for each pre-engineered metal building;

9. The total value of the solids pond upgrade;

10. The total value of site civil Work, inclusive of clearing and grubbing, demolition, paving, gravel surfacing, fencing and gates, septic drain field, grading and drainage Work, and;

11. The total value of landscaping;

12. The total value of other Work not specifically included in the above items.

C. Review and Revisions

1. The Contractor and Engineer shall meet and jointly review the preliminary Schedule of Values and make any adjustments in value allocations if, in the opinion of the Engineer, these are necessary to establish fair and reasonable allocation of values for the major Work components.

2. Front-end loading will not be accepted.

3. The Engineer may require reallocation of major Work components from items in the above listing if in the opinion of the Engineer such reallocation is necessary.

4. This review and any necessary revisions shall be completed within fifteen (15) Days from the date of Notice to Proceed.

1.04 DETAILED SCHEDULE OF VALUES

A. Prepare and submit a detailed Schedule of Values to the Engineer within thirty (30) Days from the date of Notice to Proceed.

B. Base the detailed Schedule of Values on the accepted preliminary Schedule of Values for major Work components.

C. Because the ultimate requirement is to develop a detailed Schedule of Values sufficient to determine appropriate monthly progress payment amounts through cost loading of the Schedule activities, furnish a sufficiently detailed breakdown in order to meet this requirement.

D. The Engineer will be the sole judge of acceptable numbers, details and description of values established.

E. If, in the opinion of the Engineer, a greater number of Schedule of Values items than proposed is necessary, add the additional items so identified by the Engineer.

F. Submit the minimum detail of breakdown of the major Work components as follows; furnish greater detail if requested by the Engineer:

1. Mobilization: no breakdown required;

2. Section 01 32 14 – Barchart Construction Schedule: break down by submittal;

3. Break down the electrical Work by structure and yard facilities, as follows:

   a. Break down structures electrical Work into conduit and raceway installation, cable and wire installation, electrical equipment installation, terminations, and lighting; and,

   b. Break down yard facilities electrical Work by duct bank designation and substations;

4. Break down instrumentation and control Work by structure;

5. Protective Coating Work:

   a. Break down protective coating Work by structure and yard area;

   b. Where specific coating Work at structures or yard areas may be critical to performing the Work in order to meet milestone and Contract Times, such Work shall be included as individual pay and Schedule activity items;

6. Yard Piping Work:

   a. Break down into individual pipelines running from and to Contract termination points.

   b. Each pipeline shall be an individual pay item unless otherwise allowed by the Engineer.

7. Break down mechanical Work within each structure in order to identify individual piping systems, equipment installation by equipment name and number, and equipment testing and checkout.

8. Break down concrete structures into excavation, subgrade preparation, and appurtenant pre-foundation Work, concrete foundation construction, slabs on grade, walls/columns, suspended slabs, stairs, and the like (provide sufficiently detailed breakdown in order to accommodate necessary Schedule detail), hydrostatic structure testing, where required, and backfill.

9. Break down pre-engineered metal buildings into building frame erection, roofs, decks, siding and soffit Work, insulation, doors/windows/louvers, and other items determined to be necessary for the establishment of pay and schedule activity items.

10. Break down the ponds into excavation, earthwork subgrade protection and preparation, concrete base, sloped concrete, access ramps/roadways, and other items determined to be necessary for the establishment of pay and schedule activity items.

11. Break down civil site Work into individual drainage piping, drainage structures, site concrete, paving, gravel surfacing, demolition, excavation cut and fill, removal of existing pipe, clearing and grubbing, fencing and gates, septic drain field, and other items determined to be necessary for the establishment of pay and schedule activity items.

12. Breakdown of landscaping into planting, soil amendments and irrigation.

13. Break down pre-commissioning and commissioning based on completion milestones for each.

14. Break down other Work not specifically included in the above items, as necessary for the establishment of pay and schedule activity items.

G. Adjustments and Acceptance

1. The Contractor and Engineer shall meet and jointly review the detailed Schedule of Values within 35 Days from the date of Notice to Proceed, at which time the value allocations and extent of detail shall be reviewed in order to determine if necessary adjustments to the values are required, and to determine if sufficient detail has been proposed in order to allow acceptable cost loading of the Schedule activities.

2. Make necessary adjustments to the value allocation or level of detail, and submit a revised detailed Schedule of Values within forty (40) Days from the date of Notice to Proceed.

3. Following acceptance of the detailed Schedule of Values, incorporate the values into the Schedule.

4. It is anticipated that instances will occur, due to the independent but simultaneous development of the Schedule of Values and the Schedule activities, where interfacing these two (2) documents will require changes to each document.

5. Schedule activities may need to be added to accommodate the detail of the Schedule of Values, and Schedule of Value items may need to be added to accommodate the detail of the Schedule activities.

6. Where such instances arise, propose changes to the Schedule of Values and to the Scheduled activities in order to satisfy the Engineer.

1.05 CHANGES TO SCHEDULE OF VALUES

A. Changes to the Schedule which additional activities not included in the original schedule but included in the original Work (schedule omissions) shall have values assigned as approved by the Engineer.

B. Reduce other activity values in order to provide equal value adjustment increases for added activities, as approved by the Engineer.

C. In the event that the Contractor and Engineer agree to make adjustments to the original Schedule of Values because of inequities discovered in the original accepted detailed Schedule of Values, increases and equal decreases to values for activities may be made.

1.06 LIQUIDATED DAMAGES

A. The Schedule of Values information is an integral part of the scheduling and reporting under Section 01 32 16 – Barchart Construction Schedule and the progress payment information.

B. As such, it is critical information to evaluating progress and the proper planning of the Owner's and Engineer's Work related effort as well as their financial obligations associated with the Project.

C. Accordingly, if a submittal required by this Section is found to be incomplete or is submitted later than required, the Owner will suffer financial loss and, accordingly, liquidated damages will be assessed against the Contractor in accordance with Article 4 of the Agreement.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 14 – BARCHART CONSTRUCTION SCHEDULE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall schedule the Work in accordance with the Contract Documents.

B. Where submittals are indicated, submit a PDF document.

C. The Contractor is alerted to Section 01 14 00 – Construction Constraints.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 14 00	Construction Constraints
00 80 00	Supplementary Conditions of the Construction Contract

1.03 INITIAL SCHEDULE SUBMITTALS

A. The Contractor shall submit 2 schedule documents at the Preconstruction Conference that shall serve as the Contractor's Plan of Operation for the initial 60 Day period of the Contract Times and shall identify the manner in which the Contractor intends to complete Work within the Contract Time. The Contractor shall submit a 60 Day Plan of Operation Bar Chart Schedule and a Project Overview Bar Chart Schedule for Work as indicated below.

1. 60 Day Bar Chart Plan of Operation Schedule: The bar chart shall show the Contractor's early activities (mobilization, permits, submittals necessary for early material and equipment procurement, submittals necessary for long lead equipment procurement, scheduling submittals, initial site work, and other submittals) required in the first 60 Days).

2. Project Overview Bar Chart Schedule: The Bar Chart shall indicate the major components of the Work and the sequence relations between the major components and subdivisions of major components. The bar chart schedule shall indicate the relationships and time frames in which the various components of the Work will be made substantially complete and placed into service in order to meet the Contract Times. Sufficient detail shall be included for the identification of subdivisions of major components according to such activities as mobilization, site dewatering, excavation, demolition, yard piping installation, placement of structural backfill, final site grading, and other important Work for each major item within the overall project scope. Planned durations and start dates shall be indicated for each work item subdivision. Each major component and subdivision component shall be accurately plotted on time scale sheets not to exceed 36-inches by 60-inches in size. Not more than 4 sheets shall be employed to represent this overview information.

B. The Engineer and the Contractor shall meet to review and discuss the 60 Day Plan of Operations and Project Overview Schedules within 5 Days after submittal. The Engineer's review and comment on the schedules will be limited to conformance to the Contract Documents. The Contractor shall make corrections to the schedules necessary to comply with requirements and shall adjust the schedules to incorporate any missing information requested by the Engineer.

1.04 CHANGE ORDERS

A. Upon approval of a change order or upon receipt of authorization to proceed with additional Work, the change shall be depicted in the next submittal of the Project Overview Bar Chart Schedule.

1.05 STATUS REPORTING

A. The Contractor shall furnish monthly Project Overview Bar Chart Schedules and written narrative reports in the form indicated below.

B. The Project Overview Bar Chart Schedule shall be a summary of the current construction schedule for major project components (original and as updated and adjusted throughout the entire construction period). It shall be limited to not more than 4 pages and shall be a PDF document. The major project components shall be represented as time bars which shall be subdivided into various types of Work including dewatering, excavation, demolition, yard piping, placement of structural backfill, and final site grading.

C. Each major component and subdivision shall be plotted accurately on a time scale consistent with the early start and finish activity information contained in the latest update of the schedule. In addition, a percent completion shall be listed for each major component and subdivision. The Contractor shall amend the Project Overview Bar Chart Schedule as necessary to include any additional detail required by the Engineer. The Contractor shall include any additional information requested by the Engineer at any time during construction.

D. The Contractor shall prepare monthly written narrative reports of the status of the project for submission to the Engineer. Status reports shall include:

1. The status of major project components (percent complete and amount of time ahead or behind schedule) and an explanation of how the project will be brought back on schedule if delays have occurred.

2. The progress made on critical activities indicated on the construction schedule.

3. Explanations for any lack of Work on critical activities planned to be performed during the last month.

4. Explanations for any schedule changes, including changes to the logic or to activity durations.

5. A list of the critical activities scheduled for the next 2 months.

6. The status of major material and equipment procurements.

7. The value of materials and equipment properly stored at the Site but not yet incorporated into the Work.

8. Any delays encountered during the reporting period.

9. An assessment of inclement weather delays and impacts to the progress of the Work.

10. The Contractor may include any other information pertinent to the status of the project.

11. The Contractor shall include additional status information requested by the Engineer.

1.06 INCLEMENT WEATHER PROVISIONS OF THE SCHEDULE

A. The construction schedule shall include lost days on the construction schedule due to inclement weather. Inclement weather delays shall be determined in accordance with Section 00 80 00 - Supplementary Conditions of the Construction Contract.

1.07 LIQUIDATED DAMAGES

A. If any submittal required by this Section is determined by the Engineer to be incomplete or is submitted later than required, the Owner will suffer financial loss and, accordingly, liquidated damages may be assessed against the Contractor in accordance with the Agreement.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 00 – SUBMITTAL PROCEDURES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Wherever submittals are required by the Contract Documents, submit them to the Engineer.

B. Within 14 Days after the date of commencement as stated in the Notice to Proceed, submit the following items for review:

1. Submittal Schedule

a. Submit a preliminary schedule of Shop Drawings, Samples, and proposed Substitutes ("or equal") submittals listed in the Bid.

b. Base the schedule of submittals on Contractor's priority, planned construction sequence and schedule, long-lead items, and size of submittal package.

c. Allow time for resubmittals.

2. Submit a list of permits and licenses the Contractor shall obtain, indicating the agency required to grant the permit and the expected date of submittal for the permit and required date for receipt of the permit.

C. Federal Funding Requirements

1. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). All iron and steel, manufactured products, and construction materials permanently incorporated into the project must be manufactured in the United States. To ensure compliance, upon Notice to Proceed (NTP), the Contractor shall submit a Master Submittal List clearly indicating which materials are subject to BABA, which may require waivers, and which are proposed for inclusion in the De Minimis Log. Certification letters from manufacturers must accompany all submittals for BABA-covered materials. The Contractor is responsible for maintaining a BABA Tracking Log throughout the project lifecycle, and all documentation must be made available for audit and review. Failure to comply with these requirements may result in enforcement actions, including cost recovery or disallowance of federal funding.

2. The project is subject to American Iron and Steel (AIS) requirements under the Consolidated Appropriations Act of 2017 (Section 746 Division A of Title VII) mandating for all iron and steel products to be produced in the United States. BABA requirements for Iron and Steel are equivalent to those under AIS.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 10 00	Summary of Work
01 29 73	Schedule of Values

01 32 14	Barchart Construction Schedule
01 52 00	Field Office, Equipment, and Services
01 60 00	Products, Materials, Equipment, and Substitutions
01 77 00	Project Closeout

1.03 PRECONSTRUCTION CONFERENCE SUBMITTALS

A. At the preconstruction conference of Section 01 10 00 – Summary of Work, submit the following items to the Engineer for review:

1. a revised schedule of Shop Drawings, Samples, and proposed Substitution ("or-equal") submittals listed in the Bid;

2. a list of permits and licenses the Contractor shall obtain, indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit;

3. a preliminary schedule of values in accordance with Section 01 29 73 – Schedule of Values;

4. a 60-Day plan of operation in accordance with Section 01 32 14 – Barchart Construction Schedule;

5. a detailed layout of the field office required under Section 01 52 00 – Field Office, Equipment, and Services; the office shall not be shipped to the Site until the layout is approved.

1.04 SHOP DRAWINGS

A. Wherever called for in the Contract Documents or where required by the Engineer, furnish one copy plus one reproducible copy of each Shop Drawing submittal.

B. Shop Drawings may include detail design calculations, shop-prepared drawings, fabrication and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items.

C. Whenever the Contractor is required to submit design calculations as part of a submittal, such calculations shall bear the signature and seal of an engineer registered in Washington.

D. Transmittal Form

1. Shop Drawing submittals shall be accompanied by the Engineer's standard submittal transmittal form, a reproducible copy of which is available from the Engineer.

2. A submittal without the form, or where applicable items on the form have not been completed, will be returned for resubmittal.

E. Organization

1. Use a single submittal transmittal form for each technical specification Section or item or class of material or equipment for which a submittal is required.

2. A single submittal covering multiple Sections will not be accepted, unless the primary specification references other Sections for components: For example, if a pump Section references other Sections for the motor, shop-applied protective coating, anchor bolts, local control panel, and variable frequency drive, a single submittal would be accepted, whereas a single submittal covering vertical turbine pumps and horizontal split-case pumps would not be accepted.

3. On the transmittal form, index the components of the submittal.

4. Relate the submittal components to specification paragraph and subparagraph, Drawing number, detail number, schedule title, room number, or building name, as applicable.

5. Unless otherwise indicated, match terminology and equipment names and numbers used in the submittals with those used in the Contract Documents.

F. Format

1. Submittals shall be submitted as a PDF document.

2. Number every page in a submittal in sequence.

3. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with complete pertinent data capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports.

4. Present a sufficient level of detail for assessment of compliance with the Contract Documents.

5. Before accepting the number system option in the following Subparagraph, the Specifier should verify that the document tracking system to be used in the field office will function under an alphanumeric system. If not, select the second optional wording for compatibility.

6. Numbering

a. Assign to each submittal a unique number.

b. Number the submittals sequentially, with the submittal numbers clearly noted on the transmittal.

c. Assign original submittals a numeric submittal number followed by a decimal point and a numeric digit in order to distinguish between the original submittal and each resubmittal: For example, if submittal "25.1" requires a resubmittal, the first resubmittal will bear the designation "25.2" and the second resubmittal will bear the designation "25.3," and so on.

G. Disorganized submittals that do not meet the requirements of the Contract Documents will be returned without review.

H. Engineer's Review

1. Except as otherwise indicated, the Engineer will return prints of each submittal to the Contractor with comments noted thereon, within 30 Days following receipt by the Engineer.

2. It is considered reasonable that the Contractor shall make a complete and acceptable submittal to the Engineer by the first resubmittal on an item.

3. The Owner reserves the right to withhold monies due to the Contractor to cover additional costs of the Engineer's review beyond the first resubmittal.

4. The Engineer's maximum review period for each submittal or resubmittal will be 30 Days; thus, for a submittal that requires 2 resubmittals before it is complete, the maximum review period could be 120 Days.

I. If a submittal is returned to the Contractor marked "NO EXCEPTIONS TAKEN," formal revision and resubmission will not be required.

J. If a submittal is returned marked "MAKE CORRECTIONS NOTED," the Contractor shall make the corrections on the submittal, but formal revision and resubmission will not be required.

K. Resubmittals

1. If a submittal is returned marked "AMEND-RESUBMIT," the Contractor shall revise the submittal and resubmit the required number of copies.

2. Resubmittal of portions of multi-page or multi-drawing submittals will not be accepted: For example, if a Shop Drawing submittal consisting of 10 drawings contains one drawing noted as "AMEND-RESUBMIT," the submittal as a whole is deemed "AMEND-RESUBMIT," and 10 drawings are required to be resubmitted.

3. Every change from a submittal to a resubmittal or from a resubmittal to a subsequent resubmittal shall be identified and flagged on the resubmittal.

L. Rejected Submittals

1. If a submittal is returned marked "REJECTED-RESUBMIT," it shall mean either that the proposed material or product does not satisfy the specification, the submittal is so incomplete that it cannot be reviewed, or is a substitution request not submitted in accordance with Section 01 60 00 – Products, Materials, Equipment, and Substitutions.

M. The fabrication of an item may commence only after the Engineer has reviewed the pertinent submittals and returned copies to the Contractor marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

N. Corrections indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as changes to the contract requirements.

O. Review by Contractor

1. Submittals shall be carefully reviewed by an authorized representative of the Contractor prior to submission to the Engineer.

2. Each submittal shall be dated and signed by the Contractor as being correct and in strict conformance with the Contract Documents.

3. In the case of Shop Drawings, each sheet shall be so dated and signed.

4. Any deviations from the Contract Documents shall be noted on the transmittal sheet.

5. The Engineer will only review submittals that have been so verified by the Contractor.

6. Non-verified submittals will be returned to the Contractor without action taken by the Engineer, and any delays caused thereby shall be the total responsibility of the Contractor.

P. Conformance

1. Corrections or comments made on the Contractor's Shop Drawings during review shall not relieve the Contractor from compliance with Contract Drawings and Specifications.

2. A lack of comments made on the Contractor’s Shop Drawings during review shall not relieve the Contractor from compliance with Contract Drawings and Specifications.

3. Review is for conformance to the design concept and general compliance with the Contract Documents only.

4. The Contractor shall be responsible for confirming and correlating quantities and dimensions, fabrication processes and techniques, coordinating Work with the trades, and satisfactory and safe performance of the Work.

1.05 SAMPLES

A. Quantity

1. The Contractor shall submit the number of samples indicated by the Specifications.

2. If the number is not indicated, submit not less than 3 samples.

3. Where the quantity of each sample is not indicated, submit such quantity as necessary for proper examination and testing by the methods indicated.

B. Identification and Distribution

1. Individually and indelibly label or tag each sample, indicating the salient physical characteristics and the manufacturer's name.

2. Upon acceptance by the Engineer, one set of samples will be retained by the Engineer, and one set shall remain at the Site in the Engineer's field office until completion of the Work.

C. Selection

1. Unless otherwise indicated, the Engineer will select colors and textures from the manufacturer's standard colors and standard materials, products, or equipment lines.

2. If certain samples represent non-standard colors, materials, products, or equipment lines that will require an increase in Contract Times or Price, the Contractor shall clearly state so on the transmittal page of the submittal.

D. The Contractor shall schedule sample submittals such that:

1. Sample submittals for color and texture selection are complete so the Engineer has 45 Days to assemble color panels and select color- and texture-dependent products and materials without delay to the construction schedule; and,

2. After the Engineer selects colors and textures, the Contractor has sufficient time to provide the products or materials without delay to the construction schedule.

3. The Contract Times will not be extended for the Contractor's failure to allow enough review and approval or selection time, failure to submit complete samples requiring color or texture selection, or failure to submit complete or approvable samples.

1.06 TECHNICAL MANUAL

A. The Contractor shall submit technical operation and maintenance information for each item of mechanical, electrical, and instrumentation equipment in an organized manner in the Technical Manual.

B. The manual shall be written such that it can be used and understood by the Owner's operation and maintenance staff.

C. The Specifier must consider whether the organization of information in the manuals is appropriate for the scope of the Work. If possible during customization, discuss the manual organization with Owner staff and O&M manual specialists.

D. Categories

1. The Technical Manual shall be subdivided first by Specification Section number; second, by equipment item; and last, by "Category." The following "Categories" shall be addressed (as applicable):

a. Category 1 - Equipment Summary

1) Summary: A table shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

2) Form: The Engineer will supply an Equipment Summary Form for each item of mechanical, electrical, and instrumentation equipment in the Work. The Contractor shall fill in the relevant information on the form and include it in Part 1.

b. Category 2 - Operational Procedures

1) Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

a) Installation

b) Adjustment

c) Startup

d) Location of controls, special tools, equipment required, or related instrumentation needed for operation

e) Operation procedures

f) Load changes

g) Calibration

h) Shutdown

i) Troubleshooting

j) Disassembly

k) Reassembly

l) Realignment

m) Testing to determine performance efficiency

n) Tabulation of proper settings for pressure relief valves, low and high pressure switches, and other protection devices

o) List of all electrical relay settings including alarm and contact settings

c. Category 3 - Preventive Maintenance Procedures

1) Procedures: Preventive maintenance procedures shall include manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by maintaining the equipment in place.

2) Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

d. Category 4 - Parts List

1) Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

2) Drawings: Cross-sectional or exploded view drawings shall accompany the parts list. Part numbers shall appear on the drawings with arrows to the corresponding part.

e. Category 5 - Wiring Diagrams

1) Diagrams: Category 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

f. Category 6 - Shop Drawings

1) Drawings: This category includes approved shop or fabrication drawings with Engineer comments and corrections incorporated, complete with dimensions.

g. Category 7 - Safety

1) Procedures: This category describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

h. Category 8 - Documentation:

1) Equipment warranties, affidavits, certifications, calibrations, laboratory test results, etc. required by the Technical Specifications shall be placed in this category.

E. Format

1. Bind each Technical Manual in standard size 3-ring hardcover binders, labeled on the spine and cover with Project name, Owner's project number, Specification Section number, equipment name, and equipment identification number

2. Each Binder shall contain its own detailed table of contents at the front, plus a summary level table of contents information for the other binders in a multi-binder set.

3. Documents in binders shall be 3-hole punched, with no text punched out, and pages larger than 8-1/2 by 11 shall be folded to 8-1/2 by 11 size.

4. Provide electronic files with each final set of Technical Manuals, as follows:

a. Project-specific files created in the latest version of Microsoft Word;

b. AutoCad, version, latest version;

c. Adobe Acrobat portable document format (PDF) or other software required by the Specifications; and,

d. Manufacturer literature in Adobe Acrobat portable document format (PDF).

F. Review Process

1. Furnish 3 draft Technical Manuals for each Specification Section that requires a manual.

2. The Engineer will retain one copy, will forward one copy to the Owner, and will return one copy to the Contractor with review comments.

3. Incorporate comments into the draft and submit 2 identical copies of the final manual for acceptance.

G. Schedule

H. The first alternative paragraph below is for a project with all new construction where interest in manuals increases as the day approaches when the Owner staff receives training on all the new equipment. The second paragraph is for rehabilitation projects or those with new equipment installed at multiple locations within an existing facility. In this case, Owner occupancy of new equipment can begin long before the end of construction. Retain one paragraph or the other, but not both.

I. Submittal and Corrections

1. The Work under this Contract involves start-up and commissioning of equipment in multiple areas of the facility at independent times within the Project Schedule.

2. The manuals shall be completed for each piece of equipment prior to final acceptance of the equipment by the Owner.

3. Except as otherwise indicated, submit the manuals for review in final form a minimum of 30 Days prior to the start of performance testing for each piece of equipment.

4. Discrepancies found by the Engineer shall be corrected within 30 Days from the Date of written notification by the Engineer.

J. Manuals that are incomplete or unacceptable at the schedule criterion above will constitute sufficient justification for the Owner to retain the amount in Paragraph "Technical Manual Submittals" of Section 01 77 00 – Project Closeout, from any monies due the Contractor.

K. If the parts list would be the same as the spare parts list on the Project, Paragraph 1.6A could be incorporated into Category 4 of the Technical Manual, above.

1.07 SPARE PARTS LIST

A. General

1. Furnish to the Engineer 3 identical sets of spare parts information for mechanical, electrical, and instrumentation equipment.

2. The spare parts list shall include those spare parts that each manufacturer recommends to be maintained by the Owner in inventory.

B. Sources and Pricing

1. The spare parts list shall include a current list price of each spare part.

2. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts, to assist the Owner in ordering.

C. Format

1. Cross-reference the spare parts lists to the equipment numbers designated in the Contract Documents.

2. The spare parts lists shall be

3. The binder ring size shall not exceed 2-1/2 inches.

4. Each copy of the spare parts lists shall be accompanied by an electronic version containing the lists in a PDF electronic format.

1.08 AS-BUILT DRAWINGS

A. On-Site Drawings Set

1. Maintain one set of Drawings at the Site for the preparation of as-built drawings.

2. On this set, mark every project condition, location, configuration, and any other change or deviation which may differ from the Contract Drawings at the time of award, including buried or concealed construction and utility features that are revealed during the course of construction.

3. Give special attention to recording the horizontal and vertical location of buried utilities that differ from the locations indicated, or that were not indicated on the Contract Drawings.

4. Supplement the as-built drawings by any detailed sketches as necessary or as directed, in order to fully indicate the Work as actually constructed.

5. The as-built drawings are the Contractor's representation of as-built conditions, shall include revisions made by addenda and change orders, and shall be maintained up-to-date during the progress of the Work.

6. Use red font for alterations and notes.

7. Notes shall identify relevant Change Orders by number and date.

B. Submittal

1. Submit paper copies of the as-built drawings on the 20th Day of every third month after the month in which the Notice to Proceed is given, as well as at completion of the Work.

2. Failure to submit complete as-built drawings on or before the 20th Day will enact the liquidated damages clause for interim record drawing submittals described in Article 3 of the Agreement.

C. In the case of those drawings that depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, update the as-built drawings by indicating those portions which are superseded by Change Order drawings or final Shop Drawings, and by including appropriate reference information describing the Change Orders by number and the Shop Drawings by manufacturer, drawing, and revision numbers.

D. Unacceptable Drawings

1. Disorganized or incomplete as-built drawings will not be accepted.

2. The Contractor shall revise them and resubmit within 10 Days.

E. As-built drawings shall be accessible to the Engineer during the construction period.

F. Final Payment

1. Final payment will not be acted upon until the as-built drawings have been completed and delivered to the Engineer.

2. Up-to-date as-built drawings shall be in the form of a set of prints with carefully plotted information overlaid in AutoCad, latest version.

G. Information submitted by the Contractor will be assumed to be correct, and the Contractor shall be responsible for the accuracy of such information

1.09 QUALITY CONTROL (QC) SUBMITTALS

A. Quality control submittals are defined as those required by the Specifications to present documentary evidence to the Engineer that the Contractor has satisfied certain requirements of the Contract Documents.

B. Unless otherwise indicated, QC submittals shall be submitted:

1. Before delivery and unloading, for the following types of submittals:

a. Manufacturers' installation instructions

b. Manufacturers' and Installers' experience qualifications

c. Ready mix concrete delivery tickets

d. Design calculations

e. Affidavits and manufacturers' certification of compliance with indicated product requirements

f. Laboratory analysis results

g. Factory test reports

2. Within 30 Days of the event documented for the following types of submittals:

a. Manufacturers' field representative certification of proper installation

b. Field measurement

c. Field test reports

d. Receipt of permit

e. Receipt of regulatory approval

C. The Engineer will record the date that a QC submittal was received and review it for compliance with submittal requirements, but the review procedures above for Shop Drawings and samples will not apply.

D. Retain the following article only if our CM forms will be used.

1.10 INFORMATIONAL SUBMITTALS

A. Informational submittals formalize the flow of information between the Contractor and the Engineer.

B. Electronic forms shall be obtained from the Engineer for such purpose.

C. The following forms may be used, but the list is not necessarily inclusive:

1. CM - 205 Allocation of Total Contract Price

2. CM - 302 Request for Clarification

3. CM - 306 Contractor’s Submittal Transmittal Form

4. CM - 307 Memorandum of Delay

5. CM - 432 System Outage Request

6. CM - 501 Request for Construction Staking

7. CM - 503 Request for Shutdown

8. CM - 1001 Monthly Payment Estimate Summary

9. CM - 1003 Request for Payment for Material on Hand

10. CM - 1004 Request for Adjustment of Retainage

11. CM - 1005 Consent of Surety for Reduction of Partial Release of Retainage

12. CM - 1006 Consent of Surety for Final Payment

13. CM - 1007 Affidavit of Payment

14. CM - 1101 Field Order

15. CM - 1102 Initiator Change Order Request

16. CM - 1106 Deviation Request

17. CM - 1110 Substitution Request Form

18. CM - 1202 Contractor's Certification of Completion

19. CM - 1301 Partial Waiver of Lien

20. CM - 1302 Final Waiver of Lien

D. CM - 1303 Affidavit of Release of Lien

1.11 CONSTRUCTION PHOTOGRAPHS

A. General

1. Furnish construction photographs showing the progress of the Work.

2. Provide electronic JPEG photos with the date of photographing, the project title, a short description of what is in the photograph, and the direction the camera is facing.

B. Prints and Negatives

1. Starting when the Work begins and continuing for as long as the Work is in progress, take not less than 12 images at intervals not more than 2 weeks apart, consisting of different subjects or angles or view at different locations of progress on the Site.

2. Furnish to the Engineer within 2 weeks after the date photos are taken.

3. The JPEG photos shall become sole property of the Owner upon submittal by the Contractor.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 33 17 – STRUCTURAL DESIGN, SUPPORT AND ANCHORAGE

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide calculations and details for structural and non-structural components, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The Contractor shall furnish and install all such structural and non-structural components, supports, and anchorages in accordance with the calculations and details.

B. The Contractor shall provide calculations and details for structures and non-building structures, supports, and anchorages as required by the Contract Documents and the 2021 IBC. The Contractor shall furnish and install all such structures and non-building structures, supports, and anchorages in accordance with the calculations and details.

C. Where a conflict exists between the requirements of the Contract Documents and the 2021 IBC, the more stringent requirement shall apply.

D. Design parameters used to determine Seismic and Wind design forces shall be as listed herein.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
03 60 00	Grouting
05 50 00	Metal Fabrications
05 05 19	Post-Installed Concrete Anchors

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

IBC	2021 International Building Code
American Society of Civil Engineers (ASCE)	
ASCE 7 -16	Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
American Concrete Institute (ACI)	
ACI 318	Building Code Requirements for Structural Concrete (2019 edition)
ACI 350.3	Seismic Design of Liquid-Containing Concrete Structures and Commentary (2006 Edition)
The Masonry Society (TMS)	
TMS 402	Building Code for Masonry Structures (2016 edition)
TMS 602	Specification for Masonry Structures (2016 edition)

American Water Works Association (AWWA)	
AWWA D100	Welded Carbon Steel Tanks for Water Storage (2011 Edition)

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1. Calculations and Details

2. Calculations and details are considered a Deferred Submittal as defined in the IBC.

3. Calculations and details shall be complete, accurate, and in accordance with the requirements of the IBC and ASCE 7 and shall be signed and sealed by a Professional Engineer registered in the State of Washington.

4. Calculations shall be clear and concise and show equipment and other non-structural component anchorage forces and the capacities of the anchorage elements proposed by the Contractor. The calculations shall substantiate a complete load path from the component or equipment being anchored into the supporting structure or foundation.

5. The calculations and details shall demonstrate a complete lateral and vertical load path and shall clearly indicate all forces imposed on the supporting structure.

6. Calculations and details are required for all Non-Structural components, supports, anchorages, and attachments.

   a. Non-Structural components shall include all architectural, mechanical, and electrical components, equipment, piping, ductwork, and all other similar or related appurtenances necessary to produce the complete architectural, mechanical, and electrical systems.

7. When the Contract Documents require the Contractor to design structures or structural components, calculations and details for those structures and structural components, and their supports, anchorages, and attachments, are required.

8. When computer generated calculations and analyses are included as part (or as the whole) of the calculations, the calculations shall include, but not be limited to, the following: derivations of all input parameters; clear indication of the applicable load combinations and building code equations; diagrams of all members, geometry, loads, forces, reactions and deflections, for all components and connections; and output results demonstrating all stress, force, deflection and other Contract Document and building code requirements have been satisfied.

9. All calculations associated with anchorage into concrete or masonry shall be done using Strength Level forces and shall be in accordance with the applicable provisions of ACI 318 and TMS 402, respectively.

10. Refer to Part 2 below for additional requirements.

1.04 SEISMIC DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

    a. Risk Category: III.

    b. Seismic Design Category: D.

    c. Mapped MCE_R, 5% damped spectral response acceleration parameter at short periods: S_S = 0.592.

    d. Mapped MCE_R, 5% damped spectral response acceleration parameter at a period of 1-second: S_1 = 0.268.

    e. Site Class: D.

    f. Design, 5% damped spectral response acceleration parameter at short periods: S_{DS} = 0.613.

    g. Design, 5% damped spectral response acceleration parameter at a period of 1-second: S_{D1} = 0.685.

    h. Seismic response coefficient: Cs shall be calculated in accordance with ASCE 7-16, Supplement 3, Section 11.4.8.2, Exception 2.

    i. Long period transition period: T_L = 16 seconds

    j. Response modification coefficient, R: In accordance with ASCE 7, Tables 12.2-1, 12.14-1, 15.4-1 and 15.4-2.

    k. Seismic Importance Factor, I: 1.25.

    l. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

    m. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.

For Risk Category III Structures, include the following Ip paragraph.

    n. Component importance factor, I_p:

    o. I_p = 1.00, unless noted otherwise herein.

        1) I_p = 1.50 if any of the following conditions apply:

            a) The component is required to function for life-safety purposes after an earthquake, including fire sprinkler systems and egress stairways.

            b) The component conveys, supports, or otherwise contains toxic, highly toxic, explosive, or hazardous substances.

2. The following components are exempted from the seismic design requirements:

    a. Exemptions shall be as indicated in ASCE 7 Chapter 13.

1.05 WIND DESIGN CRITERIA

A. Design Requirements

1. Design Parameters:

a. Risk Category: III.

b. Basic 3-second Wind Gust Speed: 104 miles per hour.

c. Exposure Category: C.

d. Topographic Factor, K_{zt}: 1.0.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Non-Structural Component Supports and Anchors

1. Unless otherwise indicated, non-structural component supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic and wind loads.

a. Wall-mounted equipment weighing more than 250 lbs or which is within 18-in of the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel or engineered framing support systems. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

b. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the building code and the Contract Documents.

c. All equipment and all other non-structural components shall be supported and anchored in place by methods that satisfy the manufacturer's applicable seismic certification requirements.

2. Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.

B. Non-Building Structures

1. Non-Building Structures shall be designed in accordance with ASCE 7 Chapter 15.

2. Non-Building Structures, foundations, supports, anchors, and restrainers shall be adequately designed for all applicable static, dynamic, operational, seismic and wind loads.

3. Friction shall not be used to resist sliding due to seismic forces, except as indicated below:

a. Friction may be used to resist sliding of Welded or Bolted Steel Tanks designed in accordance with AWWA D100 or AWWA D103, respectively, when specifically permitted by that Standard.

C. Anchors – General

1. Anchor bolts shall be cast-in-place unless otherwise noted or approved by the Engineer.

2. Anchor bolts shall be in accordance with Section 05 50 00 – Metal Fabrication.

3. Adhesives and epoxies for post-installed anchors in concrete shall be in accordance with Section 05 05 19 – Post-Installed Concrete Anchors.

4. Grouts for anchor bolts shall be in accordance with Section 03 60 00 - Grouting.

5. The Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the calculations and details.

6. Anchor bolt calculations shall clearly show that the capacity of the anchor and the capacity of the concrete that the anchor is embedded in are adequate to resist all applicable load combinations, including seismic and wind loads.

    a. The design of anchors resisting seismic forces shall satisfy the ductility requirements stated in the IBC.

7. Reduction factors associated with edge distance, embed length, grout and base plate thickness, and bolt spacing shall all be considered and based on the actual dimensions of the concrete that resists the anchorage forces.

8. Where anchorage is required into or through equipment pads, the following requirements shall apply unless otherwise approved by the Engineer:

    a. For tensile forces, the embed length and associated concrete failure zone shall be provided entirely within the structural slab. No portion of the equipment pad may be considered as effective in resisting tensile forces.

    b. For shear forces, the edge distance and associated concrete failure zone shall be provided entirely within the equipment pad. No portion of the structural slab may be considered as effective in resisting shear forces.

9. Anchor bolt details shall include required bolt diameter, embed, spacing, and edge distances.

10. Where additional reinforcement is required to satisfy anchorage requirements, such reinforcement shall be included in the anchorage details, and shall be furnished and installed by the Contractor.

D. Mechanical and Electrical Equipment Foundations

1. Equipment foundations are indicated on Drawings. The Contractor, through the equipment manufacturer, shall verify the size and weight of the equipment foundation to ensure compatibility with equipment.

2. Equipment foundation dimensions shall be coordinated with the equipment base geometry and the edge distance and embed requirements of the equipment anchorage calculations.

E. Mechanical and Electrical Equipment (Housekeeping) Pads

1. General

a. Equipment, tanks, control cabinets, enclosures, and related equipment shall be mounted on concrete equipment pads, unless otherwise indicated. The top surface of the equipment pads shall be level, unless otherwise indicated, or otherwise required by the equipment manufacturer.

b. Equipment pads shall be sized to accommodate the bearing and anchorage requirements of the equipment, subject to the constraints listed below.

c. Final geometry of the equipment pads shall not result in a condition that violates applicable building code provisions, including but not limited to the provisions of the National Electric Code.

2. Mechanical Equipment Pads

a. Mechanical equipment pad heights shall be coordinated with process equipment and piping elevation requirements. Where no such elevation constraints exist, the equipment pad height shall be as shown on the drawings, or as indicated below when no specific height is provided.

1) Equipment pads for mechanical equipment shall be 3.5-in tall (maximum) at the front of the equipment.

b. Mechanical equipment pads shall extend not more than 2-in beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

1) Where necessary to meet seismic or wind anchorage requirements, the pads may be extended beyond the 2-in limit indicated above. The pads shall extend not more than 6-in beyond the front, back, and sides of the equipment.

3. Electrical Equipment Pads

a. Electrical equipment pads shall be 3.5-in tall (maximum) at the front of the equipment.

b. Electrical equipment pads shall extend not more than 2-in beyond the front, back, and sides of the equipment, except as indicated below, unless otherwise shown on the drawings.

c. Where necessary to meet seismic anchorage requirements, the pads may be extended beyond the 2-in limit indicated above. The pads shall extend not more than 6-in beyond the front, back, and sides of the equipment.

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 35 53 – SITE SECURITY

PART 1 -- GENERAL

1.01 SECURITY PROGRAM

A. The Contractor shall:

1. Protect Work, existing premises, and Owner's operations from theft, vandalism, and unauthorized entry.

2. Initiate program at mobilization.

3. Maintain program throughout construction period until Owner's occupancy of the new facility.

1.02 ENTRY CONTROL

A. The Contractor shall:

1. Restrict entry of persons and vehicles into Site and existing facilities.

2. Allow entry only to authorized persons with proper identification.

3. Maintain log of workmen and visitors and make log available to Owner on request.

B. The Contractor shall control the entrance of persons and vehicles to those related to the Owner's operations.

C. One gate may remain unlocked during work hours. All gates to remain locked outside of work hours.

D. The Contractor shall maintain a secure perimeter and replace any damaged or breached fencing or gates.

1.03 RESTRICTIONS

A. The Contractor shall not allow cameras on site or photographs taken except by written approval of Owner except for photo documentation as required by Section 01 33 00 – Submittal Procedures.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 13 – ABBREBIATIONS OF INSTITUTIONS

PART 1 -- GENERAL

1.01 GENERAL

A. Wherever in these Specifications references are made to the standards, specifications, or other published data of the various international, national, regional, or local organizations, such organizations may be referred to by their acronym or abbreviation only. As a guide to the user of the Specifications, the following acronyms or abbreviations which may appear shall have the meanings indicated herein.

1.02 ABBREVIATIONS

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
AATCC	American Association of Textile Chemists and Colorists
ABMA	American Bearing Manufacturer's Association – ABMA
ACGIH	American Conference of Governmental Industrial Hygienists
ACI	American Concrete Institute
AF&PA	American Forest and Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHAM	Association of Home Appliance Manufacturers
AI	The Asphalt Institute
AIA	American Institute of Architects
AIHA	American Industrial Hygiene Association
AIIM	Association for Information and Image Management
AIS	American Iron and Steel Requirement
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute

AITC	American Institute of Timber Construction
AMA	Acoustical Material Association
AMCA	Air Movement and Control Association International, Inc
ANS	American Nuclear Society
ANSI	American National Standards Institute, Inc.
APA	The Engineered Wood Association
API	American Petroleum Institute
APWA	American Public Works Association
ARI	Air-Conditioning and Refrigeration Institute
ASA	Acoustical Society of America
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society of Nondestructive Testing
ASQ	American Society for Quality
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWCI	American Wire Cloth Institute
AWI	Architectural Woodwork Institute
AWPA	American Wood Preservers Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BABA	Build American, Buy America
BBC	Basic Building Code, Building Officials and Code Administrators International
BHMA	Builders Hardware Manufacturer's Association

CABO	Council of American Building Officials
CDA	Copper Development Association
CEMA	Conveyors Equipment Manufacturer's Association
CGA	Compressed Gas Association
CLFMI	Chain Link Fence Manufacturer's Institute
CLPCA	California Lathing and Plastering Contractors Association
CMAA	A division/section of the Material Handling Industry of America
CPG	Compressed Gas Association
CRSI	Concrete Reinforcing Steel Institute
DCDMA	Diamond Core Drilling Manufacturer's Association
DHI	Door and Hardware Institute
DIPRA	Ductile Iron Pipe Research Association
EI	Energy Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
ETL	Electrical Test Laboratories
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
FEMA	Federal Emergency Management Association
FHWA	Federal Highway Administration
FM	Factory Mutual System
FPL	Forest Products Laboratory
HI	Hydronics Institute, Hydraulic Institute
HSWA	Federal Hazardous and Solid Waste Amendments
IAPMO	International Association of Plumbing and Mechanical Officials
IBC	International Building Code
ICBO	International Conference of Building Officials

ICC	International Code Council
ICC-ES	International Code Council Evaluation Service
ICCEC	Electrical Code
ICEA	Insulated Cable Engineers Association
IECC	International Energy Conservation Code
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFC	International Fire Code
IFGC	International Fuel Gas Code
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code, Association Connecting Electronic Industries
IRC	International Residential Code
ISA	Instrument Society of Automation
ISDI	Insulated Steel Door Institute
ISEA	Industrial Safety Equipment Association
ISO	International Organization for Standardization
ITE	Institute of Traffic Engineers
ITU-T	Telecommunications Standardization Sector of the International Telecommunications Union
LPI	Lightning Protection Institute
LRQA	Lloyd’s Register Quality Assurance
MBMA	Metal Building Manufacturer's Association
MIL	Military Standards (DoD)
MPTA	Mechanical Power Transmission Association
MSS	Manufacturers Standardization Society
NAAMM	National Association of Architectural Metal Manufacturer's
NACE	National Association of Corrosion Engineers

DASMA	Door and Access Systems Manufacturers Association International
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NCCLS	National Committee for Clinical Laboratory Standards
NCMA	National Concrete Masonry Association
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association or National Fluid Power Association
NISO	National Information Standards Organization
NIST	National Institute of Standards and Technology
NLGI	National Lubricating Grease Institute
NRCA	National Roofing Contractors Association
NSF	National Sanitation Foundation
NWWDA	National Wood Window and Door Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PPI	Plastic Pipe Institute
RCRA	Resource Conservation and Recovery Act
RIS	Redwood Inspection Service, a division of the California Redwood Association, CRA
RMA	Rubber Manufacturers Association
RVIA	Recreational Vehicle Industry Association
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers

SDI	Steel Door Institute, Steel Deck Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricator's Association
SPIB	Southern Pine Inspection Bureau
SSBC	Southern Standard Building Code, Southern Building Code Congress
SSPC	Society for Protective Coating
SSPWC	Standard Specifications for Public Works Construction
STLE	Society of Tribologists and Lubricating Engineers
TAPPI	Technical Association of the Worldwide Pulp, Paper, and Converting Industry
TFI	The Fertilizer Institute
TIA	Telecommunications Industries Association
TPI	Truss Plate Institute
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
USDA	U.S. Department of Agriculture
USEPA	United States of America Environmental Protection Agency
WCLIB	West Coast Lumber Inspection Bureau
WDMA	National Window and Door Manufacturers Association
WEF	Water Environment Federation
WI	Woodwork Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 42 19 – REFERENCE STANDARDS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Titles of Sections and Paragraphs: Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.

B. Applicable Publications: Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.

C. Specialists, Assignments: In certain instances, specification text requires (or implies) that specific Work is to be assigned to specialists or expert entities who must be engaged to perform that Work. Such assignments shall be recognized as special requirements over which the Contractor has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the Work; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of Work is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. The Contractor shall construct the Work in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.

B. Reference Standards

International Conference of Building Officials (ICBO)	
International Building Code of the International Code Council (ICC)	
National Electric Code (NEC)	
National Fire Protection Association (NFPA)	
Occupational Safety and Health Administration (OSHA)	
Title 29, Part 1926,	Construction Safety and Health Regulations, Code of Federal Regulations
Title 29, Part 1910,	Occupational Safety and Health Standards, Code of Federal Regulations
Standard Specifications for Public Works Construction (SSWPC)	

C. References to "Building Code" or International Building Code" shall mean International Building Code of the International Code Council (ICC) as amended by the local jurisdiction. References to "Mechanical Code" or "Uniform Mechanical Code," "Plumbing Code" or "Uniform Plumbing Code," "Fire Code" or "Uniform Fire Code," shall mean Uniform Mechanical Code, Uniform Plumbing Code and Uniform Fire Code of the International Association of Plumbing and Mechanical Officials (IAPMO) as amended by the local jurisdiction. "Electric Code" or "National Electric Code (NEC)" shall mean the National Electric Code of the National Fire Protection Association (NFPA). The latest edition of the codes as approved by the Municipal Code and used by the local agency as of the date that the Work is advertised for Bids shall apply to the Work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

D. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and direction prior to ordering or providing any materials or furnishing labor. The Contractor shall bid for the most stringent requirements.

E. References to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

F. References to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

G. Applicable Standard Specifications: References in the Contract Documents to "Standard Specifications" or SSPWC shall mean the Standard Specifications for Public Works Construction.

1.03 REGULATIONS RELATED TO HAZARDOUS MATERIALS

A. The Contractor shall be responsible that all Work included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.

B. Where no specific regulations exist and the Owner has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 00 – CONTRACTOR QUALITY CONTROL

PART 1 -- GENERAL

1.01 DEFINITION

A. Specific quality control requirements for the Work are indicated throughout the Contract Documents. The requirements of this Section are primarily related to performance of the Work beyond furnishing of manufactured products. The term "Quality Control" includes inspection, sampling and testing, and associated requirements.

1.02 INSPECTION AT PLACE OF MANUFACTURE

A. Unless otherwise indicated, all products, materials, and equipment shall be subject to inspection by the Engineer at the place of manufacture.

B. The presence of the Engineer at the place of manufacturer, however, shall not relieve the Contractor of the responsibility for providing products, materials, and equipment which comply with all requirements of the Contract Documents. Compliance is a duty of the Contractor and said duty shall not be avoided by any act or omission on the part of the Engineer.

1.03 SAMPLING AND TESTING

A. Unless otherwise indicated, all sampling and testing will be in accordance with the methods prescribed in the current standards of the ASTM, as applicable to the class and nature of the article or materials considered; however, the Owner reserves the right to use any generally-accepted system of sampling and testing which, in the opinion of the Engineer will assure the Owner that the quality of the workmanship is in full accord with the Contract Documents.

B. Any waiver by the Owner of any specific testing or other quality assurance measures, whether or not such waiver is accompanied by a guarantee of substantial performance as a relief from the testing or other quality assurance requirements originally indicated, and whether or not such guarantee is accompanied by a performance bond to assure execution of any necessary corrective or remedial Work, shall not be construed as a waiver of any requirements of the Contract Documents.

C. Notwithstanding the existence of such waiver, the Engineer reserves the right to make independent investigations and tests, and failure of any portion of the Work to meet any of the requirements of the Contract Documents, shall be reasonable cause for the Engineer to require the removal or correction and reconstruction of any such Work in accordance with the General Conditions.

1.04 INSPECTION AND TESTING SERVICE

A. Inspection and testing laboratory service shall comply with the following:

1. Unless indicated otherwise by the Technical Specifications, the Owner will appoint, employ, and pay for services of an independent firm to perform inspection and testing or will perform inspection and testing itself.

2. The Owner or independent firm will perform inspections, testings, and other services as required by the Engineer under Paragraph 1.3C above.

3. Reports of testing, regardless of whether the testing was the Owner's or the Contractor's responsibility, will be submitted to the Engineer , indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

4. The Contractor shall cooperate with the Owner or independent firm and furnish samples of materials, design mix, equipment, tools, storage, and assistance as requested.

5. The Contractor shall notify Engineer 24 hours prior to the expected time for operations requiring inspection and laboratory testing services.

6. Retesting required because of non-conformance to requirements shall be performed by the same independent firm on instructions by the Engineer. The Contractor shall bear all costs from such retesting.

7. For samples and tests required for Contractor's use, the Contractor shall make arrangements with an independent firm for payment and scheduling of testing. The cost of sampling and testing for the Contractor's use shall be the Contractor's responsibility.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Inspection: The Contractor shall inspect materials or equipment upon the arrival on the job site and immediately prior to installation and reject damaged and defective items.

B. Measurements: The Contractor shall verify measurements and dimensions of the Work, as an integral step of starting each installation.

C. Manufacturer's Instructions: Where installations include manufactured products, the Contractor shall comply with manufacturer's applicable instructions and recommendations for installation, to whatever extent these are more explicit or more stringent than applicable requirements indicated in Contract Documents.

END OF SECTION

SECTION 01 50 10 – PROTECTION OF EXISTING FACILITIES

PART 1 -- GENERAL

1.01 GENERAL

A. The Contractor shall protect all existing utilities and improvements not designated for removal and shall restore damaged or temporarily relocated utilities and improvements to a condition equal to or better than prior to such damage or temporary relocation, all in accordance with the Contract Documents. Initial condition shall be based on condition shown in preconstruction photography and videos.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

32 90 00	Landscape Planting

1.03 RIGHTS-OF-WAY

A. The Contractor shall not do any Work that would affect any gas, sewer, or water pipeline; any telephone, telegraph, or electric transmission line; any fence; or any other structure, nor shall the Contractor enter upon the rights-of-way involved until notified that the Owner has secured authority from the proper party.

B. After authority has been obtained, the Contractor shall give said party due notice of its intention to begin work, if required by said party, and shall remove, shore, support, or otherwise protect such pipeline, transmission line, ditch, fence, or structure, or replace the same.

1.04 PROTECTION OF SURVEY AND STREET OR ROADWAY MARKERS

A. The Contractor shall not destroy, remove, or otherwise disturb any existing survey markers or other existing street or roadway markers without proper authorization. No pavement breaking or excavation shall be started until all survey or other permanent marker points that will be disturbed by the construction operations have been properly referenced. Survey markers or points disturbed by the Contractor shall be restored after street or roadway resurfacing has been completed.

1.05 RESTORATION OF PAVEMENT

A. General: All paved areas including asphaltic concrete berms cut or damaged during construction shall be replaced with similar materials of equal thickness to match the existing adjacent undisturbed areas, except where specific resurfacing requirements have been called for in the Contract Documents or in the requirements of the agency issuing the permit. The pavement restoration requirement to match existing sections shall apply to all components of existing sections, including sub-base, base, and pavement. Temporary and permanent pavement shall conform to the requirements of the affected pavement owner. Pavements which are subject to partial removal shall be neatly saw cut in straight lines.

B. Temporary Resurfacing: Wherever required by the public authorities having jurisdiction, the Contractor shall place temporary surfacing promptly after backfilling and shall maintain such surfacing for the period of time fixed by said authorities before proceeding with the final restoration of improvements.

C. Permanent Resurfacing: In order to obtain a satisfactory junction with adjacent surfaces, the Contractor shall saw cut back and trim the edge so as to provide a clean, sound, vertical joint before permanent replacement of an excavated or damaged portion of pavement. Damaged edges of pavement along excavations and elsewhere shall be trimmed back by saw cutting in straight lines. All pavement restoration and other facilities restoration shall be constructed to finish grades compatible with adjacent undisturbed pavement.

D. Restoration of Sidewalks or Private Driveways: Wherever sidewalks or private roads have been removed for purposes of construction, the Contractor shall place suitable temporary sidewalks or roadways promptly after backfilling and shall maintain them in satisfactory condition for the period of time fixed by the authorities having jurisdiction over the affected portions. If no such period of time is so fixed, the Contractor shall maintain said temporary sidewalks or roadways until the final restoration thereof has been made.

1.06 EXISTING UTILITIES AND IMPROVEMENTS

A. General: The Contractor shall protect underground Utilities and other improvements which may be impaired during construction operations, regardless of whether or not the Utilities are indicated on the Drawings. The Contractor shall take all possible precautions for the protection of unforeseen Utility lines to provide for uninterrupted service and to provide such special protection as may be necessary. Utilities and other improvements which are adjacent but not included within the limits of an excavation required for performance of the Work shall be protected, supported, and maintained by the Contractor at his expense.

B. Except where the Drawings indicate Utilities have been field located during design or certain Utility locations shall be exposed as part of the Work, the Contractor shall be responsible for exploratory excavations as it deems necessary to determine the exact locations and depths of Utilities which may interfere with its work. All such exploratory excavations shall be performed as soon as practicable after Notice to Proceed and, in any event, a sufficient time in advance of construction to avoid possible delays to the Contractor's progress. When such exploratory excavations show the Utility location as shown on the Drawings to be in error, the Contractor shall so notify the Owner.

C. The number of exploratory excavations required shall be that number which is sufficient to determine the alignment and grade of the Utility.

D. Utilities to be Moved: In case it shall be necessary to move the property of any public utility or franchise holder, such utility company or franchise holder will, upon request of the Contractor, be notified by the Owner to move such property within 30 days. When utility lines that are to be removed are encountered within the area of operations, the Contractor shall notify the Owner 30 days in advance for the necessary measures to be taken to prevent interruption of service.

E. Utilities to be Removed: Where the proper completion of the Work requires the temporary or permanent removal and/or relocation of an existing Utility or other improvement which is indicated, the Contractor shall remove and, without unnecessary delay, temporarily replace or relocate such Utility or improvement in a manner satisfactory to the Engineer and the Owner of the facility. In cases of temporary removal or relocation, restoration to the former location shall be accomplished by the Contractor in a manner that will restore or replace the Utility or improvement to its former locations and to as good or better condition than found prior to removal.

F. Utilities that Do Not Require Removal or Moving:

1. Utilities which are adjacent to but not included within the limits of an excavation required for performance of the Work shall be protected, supported, and maintained by the Contractor at no additional cost to the Owner.

2. Utilities within the limits of the Work which can be supported and maintained in service and which do not require removal and rebuilding shall be thus supported by the Contractor at his expense, including cost of repair due to damage caused by the Contractor operations.

    a. Supports for water and gas mains, sewers, conduits, and similar utilities shall be constructed of timber or other acceptable materials; shall be supported from undisturbed foundations and shall be sufficiently substantial to ensure protection against settlement when pipe trenches or other excavations are backfilled. In all cases where permits or inspection fees are required by utilities in connection with changes to or temporary support of their conduits, the Contractor shall secure such permits and pay all permit and inspection fees.

    b. The Contractor shall assume full responsibility for maintaining all public service utilities in operation and shall support and protect or remove and rebuild them at his own expense. Such services shall not be interrupted without permission of the owner of the public service utilities.

G. Owner's Right of Access: The right is reserved to the Owner and to the owners of public utilities and franchises to enter at any time upon any public street, alley, right-of-way, or easement for the purpose of making changes in their property made necessary by the Work of this Contract.

H. Underground Utilities Indicated: Existing Utility lines that are indicated or the locations of which are made known to the Contractor prior to excavation and that are to be retained, and all Utility lines that are constructed during excavation operations shall be protected from damage during excavation and backfilling and, if damaged, shall be immediately repaired or replaced by the Contractor, unless otherwise repaired by the owner of the damaged Utility. If the owner of the damaged facility performs its own repairs, the Contractor shall reimburse said owner for the costs of repair.

I. Underground Utilities Not Indicated: In the event that the Contractor damages existing Utility lines that are not indicated or the locations of which are not made known to the Contractor prior to excavation, a verbal report of such damage shall be made within 24 hours to the Owner and a written report thereof shall be made promptly thereafter. If the Owner is not immediately available, the Contractor shall notify the Utility owner of the damage. If directed by the Owner, repairs shall be made by the Contractor under the provisions for changes and extra Work contained in Articles 10, 11, and 12 of the General Conditions.

J. Costs of locating and repairing damage and removing or relocating such Utility facilities not indicated in the Contract Documents, and for equipment on the project which was actually working on that portion of the Work which was interrupted or idled by removal or relocation of such Utility facilities, and which was necessarily idled during such work will be paid for as extra work in accordance with the provisions of Articles 10, 11, and 12 of the General Conditions.

K. Approval of Repairs: All repairs to a damaged Utility or improvement are subject to inspection and approval by an authorized representative of the Utility or improvement owner before being concealed by backfill or other work.

L. Maintaining in Service: Unless indicated otherwise, oil and gasoline pipelines, power, and telephone or the communication cable ducts, gas and water mains, irrigation lines, sewer lines, storm drain lines, poles, and overhead power and communication wires and cables encountered along the line of the Work shall remain continuously in service during all the operations under the Contract, unless other arrangements satisfactory to the Owner are made with the owner of said pipelines, duct, main, irrigation line, sewer, storm drain, pole, or wire or cable. The Contractor shall be responsible for and shall repair all damage due to its operations, and the provisions of this Section shall not be abated even in the event such damage occurs after backfilling or is not discovered until after completion of the backfilling.

1.07 TREES OR SHRUBS WITHIN PROJECT LIMITS

A. General: Except where trees or shrubs are indicated to be removed, the Contractor shall exercise all necessary precautions so as not to damage or destroy any trees or shrubs, including those lying within street rights-of-way and project limits, and shall not trim or remove any trees unless such trees have been approved for trimming or removal by the jurisdictional agency or owner. Existing trees and shrubs which are damaged during construction shall be trimmed or replaced by a certified tree specialist under permit from the jurisdictional agency and/or the Owner and paid for by the Contractor. Tree trimming and replacement shall be accomplished in accordance with the following paragraphs.

B. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. Cuts over 1 1/2 inches (38 mm) in diameter shall be coated with a tree paint product that is waterproof, adhesive, and elastic, and free from kerosenes, coal tar, creosote, or other material injurious to the life of the tree.

C. Replacement: The Contractor shall immediately notify the jurisdictional agency and the Owner if any tree or shrub is damaged by the Contractor's operations. If, the jurisdictional agency or the Owner's licensed arborist, determines that the damage is such that replacement is necessary, the Contractor shall replace the tree or shrub at its own expense. The tree or shrub shall be of a like size and variety as the one damaged, or, if of a smaller size, the Contractor shall pay to the owner of said tree a compensatory payment acceptable to the tree or shrub owner, subject to the approval of the jurisdictional agency or owner. The size of the tree or shrub shall be not less than 1 inch (25 mm) diameter nor less than 6 feet (1.8 m) in height. Planting of replacement trees and shrubs shall be in accordance with Section 32 90 00 – Planting. Unless otherwise indicated, the Contractor shall water and maintain the replacement trees and shrubs for 6 months after planting.

1.08 LAWN AREAS

A. Lawn or landscaped areas damaged during construction shall be repaired to match the pre-construction condition as indicated by the preconstruction photographs and videos.

1.09 PROTECTION OF STREAMS AND WATERWAYS

A. Stream or waterway bank trees, shrubs, and other vegetation should be left in place to help control erosion; where equipment operation requires tree removal, stumps and roots are to remain in place to help anchor the stream bank. Clearing of the stream or waterway banks should be avoided until immediately proceeding construction.

B. Prior to the onset of any stream or waterway crossing, silt barriers shall be placed along the banks where vegetation removal has occurred or is anticipated, exposed soil exists, and/or spoils or other fill materials are to be stockpiled within 50 feet (15 m) of the stream or waterway.

C. Construction within a stream or waterway will be continued until completed. A stream or waterway crossing shall not be initiated unless the Contractor is prepared to finish the work immediately. Also, work must not be initiated unless time and weather constraints have been provided for. Stream or waterway crossing work shall be restricted to periods of dry weather and low-flow conditions.

D. Backfill should be placed to extend the full width of the trench and the full length of the stream or waterway crossing as called for on the drawings. The balance of the trench should be filled so as to conform to the existing stream or waterway bed and banks.

E. Restoration should include the re-establishment of channel contours and bank stabilization and should be initiated immediately after the crossing is completed. Limit the use of rip-rap or similar stabilization techniques to areas where stream or waterway flow conditions prevent vegetative stabilization.

F. The width of the easement for the stream or waterway crossing should be restricted to only that necessary to perform the work.

G. Construction materials, supplies, equipment, excavated materials, construction debris, and any other work-related items should be stored, placed and/or operated so as to minimize interference with normal stream or waterway flow and shall be kept out of the stream or waterway channel except during actual pipe installation.

1.10 PROTECTION OF ARCHAEOLOGICAL/HISTORICAL RESOURCES

A. If, during the course of construction, evidence of deposits of historical and/or archaeological interest is found, the Contractor and subcontractors are required under the Washington Department of Archaeology + Historic Preservation. Upon discovery, the Contractor will cease operations and no further disturbance of the area will occur until an official from regulating agency has surveyed the find, made a determination of the value of the find and effect of continued construction disturbances, and submitted the results of the determination to the Owner.

Contact:	DAHP
Address:	1110 S. Capital Way, Suite 30
	Olympia, WA 98501
Phone number:	360 586 3065

1.11 NOTIFICATION BY THE CONTRACTOR

A. Prior to any excavation in the vicinity of any existing underground facilities, including all water, sewer, storm drain, gas, petroleum products, or other pipelines; all buried electric power, communications, or television cables; all traffic signal and street lighting facilities; and all roadway and state highway rights-of-way, the Contractor shall notify the respective authorities representing the owners or agencies responsible for such facilities not less than 3 business days nor more than 7 business days prior to excavation so that a representative of said owners or agencies can be present during such work if they so desire. The Contractor shall also notify DigSafe.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 51 00 – TEMPORARY UTILITIES

PART 1 -- GENERAL

1.01 SUMMARY

A. The types of utility services required for general temporary use at the Site include but are not limited to the following:

1. Water service (potable for certain uses)
2. Storm sewer
3. Sanitary sewer
4. Electric power service
5. Telephone service
6. Gas service
7. Heating and cooling

B. The Contractor shall provide the specified temporary utilities required in order to execute the Work expeditiously. Remove the temporary utilities from the Site upon completion of the Work unless specified otherwise.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 52 00	Field Offices, Equipment, and Services

1.03 JOB CONDITIONS

A. Scheduled Uses: The Contractor, in conjunction with establishing the progress schedule, shall establish a schedule for implementation and termination of service for each temporary utility at the earliest feasible time, and when approved by the Owner, change over from temporary utility service to permanent service.

1.04 PERMITTING

A. The Contractor shall make necessary applications to authorities having jurisdiction, obtain required permits, and pay all fees and related charges.

1.05 TEMPORARY USE OF OWNER'S FACILITIES

A. Permanent systems shall not be used without the written permission of the Owner.

B. If written permission is obtained to use existing heating systems or other systems temporarily before completion, entirely change lubricants, filters and other accessory items upon completion of the Work. Extend warranties to ensure that The Owner receives coverage for the full warranty period, as specified.

C. Temporary or trial usage of any mechanical machinery, apparatus, equipment or any other work or materials by The Owner supplied under the Work before final acceptance by the Owner is not to be construed as evidence of acceptance. The Owner shall have the privilege of such temporary and trial usage as soon as the Contractor claims that the Work is complete.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. The Contractor shall provide either new or used materials and equipment, that are in substantially undamaged condition and without significant deterioration and which are recognized in the construction industry by compliance with appropriate standards, as being suitable for intended use in each case. Where a portion of temporary utility is provided by utility company, the Contractor shall provide the remaining portion with matching and compatible materials and equipment and shall comply with recommendations of the utility company.

PART 3 -- EXECUTION

3.01 INSTALLATION OF TEMPORARY UTILITY SERVICES

A. General: Wherever feasible, the Contractor shall engage the utility company to install temporary service to the Site, or as a minimum, to make connection to existing utility service; locate services where they will not interfere with Work, including installation of permanent utility services; and maintain temporary services as installed for required period of use; and relocate, modify or extend as necessary from time to time during that period as required to accommodate the Work.

B. The Contractor shall pay all costs for installation, maintenance, consumption, and removal of temporary utilities.

C. Approval of Electrical Connections: Temporary connections for electricity shall be subject to approval of the power company representative and shall be removed in like manner at the Contractor's expense prior to final acceptance of the Work.

D. Separation of Circuits: Circuits used for power purposes shall be separate from lighting circuits.

E. Construction Wiring: Wiring for temporary electric light and power shall be properly installed and maintained and shall be securely fastened in place. Electrical facilities shall conform to the requirements of Subpart K of the OSHA Safety and Health Standards for Construction.

3.02 INSTALLATION OF POWER DISTRIBUTION SYSTEM

A. Power: The Contractor shall provide power required for its operations under the Contract and shall provide and maintain temporary power lines required to perform the Work in a safe and satisfactory manner. The Contractor shall arrange with the utility company to extend electric service to the Project Work Site, connect temporary service in a manner directed by the utility company officials, and provide separate meter for metering of power used by all entities authorized to be at or perform Work at the Project Work Site.

B. Temporary Power Distribution: The Contractor shall provide a weatherproof, grounded, temporary power distribution system sufficient for performance of the entire Work, including temporary electrical heating where indicated, operation of test equipment and test operation of building equipment and systems which cannot be delayed until permanent power connections are operable, temporary operation of other temporary facilities, including permanent equipment and systems which must be placed in operation prior to use of permanent power connections (pumps, HVAC equipment, elevators, and similar equipment), and power for temporary operation of existing facilities (if any) at the Site during change-over to new permanent power system. Provide circuits of adequate size and proper power characteristics for each use; run circuit wiring generally overhead, and rise vertically in locations where it will be least exposed to possible damage from construction operations and will result in minimal interference with performance of the Work; provide rigid steel conduit or equivalent raceways for wiring which must be exposed on grade, floors, decks, or other exposures to damage or abuse.

3.03 INSTALLATION OF LIGHTING

A. Construction Lighting: Work conducted at night or under conditions of deficient daylight shall be suitably lighted in accordance with local lighting ordinances and to afford adequate facilities for inspection and safe working conditions. Lighting shall be provided and maintained adequately to safely perform the Work. Contractor shall provide a general, weatherproof, grounded temporary lighting system in every area of construction as soon as overhead floor/roof deck structure has been installed to provide sufficient illumination for safe working and traffic conditions. Run circuit wiring generally overhead and rise vertically in locations where it will be least exposed to possible damage from construction operations on grade, floors, decks, or other areas of possible damage or abuse.

B. Light pollution off the Site shall be avoided and the construction lighting impact off the Site shall be addressed in the Construction Management plan in accordance with the local lighting ordinance.

3.04 WATER SUPPLY

A. The Contractor shall provide facilities necessary to convey the water from the source to the points of use such as reduced pressure backflow preventers, hydrant meters, and NSF 61 piping in accordance with the requirements of the Contract Documents. Water capacity charges and the wet tap fees will be paid by the Owner. The Contractor shall pay the fee for water meter and other charges for water use.

B. General: The Contractor shall provide an adequate supply of water of a quality suitable for all domestic and construction purposes.

C. Water Connections: The Contractor shall not make connection to or draw water from any fire hydrant or pipeline without first obtaining permission of the authority having jurisdiction over the use of said fire hydrant or pipeline and from the agency owning the affected water system. For each such connection made, the Contractor shall first attach to the fire hydrant or pipeline a reduced pressure backflow preventer, valve and meter, of a size and type acceptable to said authority and agency. The Contractor shall pay permit and water charges.

D. The Contractor shall comply with disinfection and testing requirements as if the temporary water supply system was a permanent system.

3.05 INSTALLATION OF SANITARY FACILITIES

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of Contractor's employees and visitors. Toilets at construction sites shall conform to the requirements of Subpart D, Section 1926.51 of the OSHA Standards for Construction. Provide separate field office facilities in conformance with Section 01 52 00 – Field Offices, Equipment, and Services.

B. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in accordance with laws and regulations pertaining thereto.

C. Contractor shall provide toileting consumables and maintain sanitation facilities in a clean condition for the duration of the Work.

3.06 INSTALLATION OF FIRE PROTECTION

A. Fire Protection: The construction plant and the Work shall be connected with the Contractor's temporary water supply system and shall be adequately protected against damage by fire. Hose connections and hose, water casks, chemical equipment, or other sufficient means shall be provided for fighting fires in the temporary structures and other portions of the Work, and responsible persons shall be designated and instructed in the operation of such fire apparatus so as to prevent or minimize the hazard of fire. The Contractor's fire protection program shall conform to the requirements of Subpart F of the OSHA Standards for Construction.

3.07 INSTALLATION OF HEATING AND COOLING

A. Temporary Heating and Cooling: Provide temporary heating and cooling system required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

B. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

C. Temporary heating and cooling systems shall be paid for by the Contractor.

3.08 OPERATIONS AND TERMINATIONS

A. Inspections: Prior to placing temporary utility services into use, the Contractor shall inspect and test each service and arrange for governing authorities' required inspection and tests and obtain required certifications and permits for use thereof.

B. Protection: The Contractor shall maintain distinct markers for underground lines and protect from damage during excavating operations.

C. Termination and Removal: When need for a temporary utility service or a substantial portion thereof has ended, or when its service has been replaced by use of permanent services, or not later than time of substantial completion, the Contractor shall promptly remove installation unless requested by the Owner to retain it for a longer period. The Contractor shall complete and restore Work which may have been delayed or affected by installation and use of temporary utility, including repairs to construction and grades and restoration and cleaning of exposed surfaces.

D. Removal of Water Connections: Before final acceptance of the Work on the project, temporary connections and piping installed by the Contractor shall be entirely removed and affected improvements shall be restored to original condition in accordance with the preconstruction video and photographs, to the satisfaction of the Owner and to the agency owning the affected utility.

END OF SECTION

SECTION 01 52 00 – FIELD OFFICE, EQUIPMENT, AND SERVICES

PART 1 -- GENERAL

1.01 SUMMARY

A. This section includes requirements of field offices for the resident project representative and/ or other representatives of the Owner

B. The Contractor shall provide field offices and equipment and furnish related services at the Site.

C. The office shall be located close to Contractor's field office, at a location designated by the Owner or as shown on the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 71 13	Mobilization
01 33 00	Submittal Procedures
01 51 00	Temporary Utilities
01 10 00	Summary of Work
01 45 00	Contractor Quality Control
01 29 73	Schedule of Values
01 35 53	Site Security

1.03 FIELD OFFICE SCHEDULE

A. Field offices, equipped as indicated herein, shall be provided at the Site, ready for exclusive use by the Owner and the Owner's representative within 14 Days after the commencement date stated in the Notice to Proceed. The Contractor's attention is directed to the condition that no payment for that portion of the Contract Price designated for mobilization, or any part thereof, will be approved for payment until the field office facilities indicated herein have been provided. The provisions for such payment are included in Section 01 71 13 - Mobilization.

B. Unless released earlier by the Owner in writing, field office(s) shall be maintained in full operation at the Site with all utilities connected and operable until the Notice of Completion has been executed or recorded. Upon execution or recordation of the Notice of Completion, or upon early release of the field office by the Owner, the Contractor shall remove the field office within 14 Days from said date and shall restore the Site occupied by the field office to the condition indicated.

PART 2 -- PRODUCTS

2.01 OFFICE FACILITIES

A. General: The Contractor shall provide necessary electrical wiring, plumbing, toilet and lavatory fixtures, air conditioning and heating equipment, and shelving, and shall furnish light, heat, water, and janitorial services in connection with the field office. Adequate all weather access, drives, parking areas, and walks shall also be provided.

B. Primary Field Office: The office shall be one separate, well lighted, air conditioned, electrically-heated field office with an ADA compliant toilet room containing a water closet and lavatory partitioned off from the working area. The water closet may be of the chemical type provided that it is a flush type with an approved holding tank. The toilet room door shall be provided with a latch set. The office shall have an outside door lock. Area of the field office shall not be less than 500 sq ft, including the toilet room area. Office shall be of the portable trailer type unless otherwise specifically authorized by the Owner in writing and shall be a separate unit, not attached or connected to any other structures. The office shall have as minimum one conference room, and one common area that can accommodate at least 2 desks. The floor plan shall be submitted to and approved by the Owner.

2.02 FIELD OFFICE FURNISHINGS

A. The Contractor shall furnish the following items in good condition in the primary field office:

B. Provide the following moveable items”

1. 3 office chairs.
2. 1 waste baskets.
3. 1 table 40-in by 96-in.
4. 1 10 lb Class ABC fire extinguisher.
5. 1 first aid kit, containing adhesive strips, gauze pads, triangular bandages, roll adhesive tape, antiseptic wipes, latex examination gloves, scissors, forceps, eye flush, cold pack, burn ointment, sting relief wipes and ibuprofen tablets.
6. 1 3 cu. ft self-defrosting refrigerator with freezer compartment.
7. 1 counter-top size microwave oven, 1 cu. ft minimum.
8. Potable drinking water and water cooler.
9. Furnish, for the duration of the project, a reliable broadband Internet connection (Digital Subscriber Line speed or better).

2.03 FIELD OFFICE SERVICES

A. Each field office shall be provided with sufficient lighting to produce not less than 50 foot-candles at desktop height at each desk location. Exterior lighting shall be provided over the entrance door.

B. Heating and air conditioning shall be provided throughout all rooms in the trailer.

C. A minimum of 4 110 VAC duplex grounded electric convenience outlets shall be provided in each office and in the conference room and common area. At least one such outlet shall be located on each wall. The electric distribution panel shall service not less than 2 110 VAC circuits.

D. Sanitary waste material shall be regularly pumped out and the chemicals recharged. Toilet paper and paper towels shall be furnished for each toilet facility.

E. Janitorial services shall be furnished during working hours every other day. Offices shall be swept, dusted, and waste receptacles emptied. Toilet facilities shall be sanitized and cleaned, and paper supplies shall be replenished.

PART 3 -- EXECUTION

3.01 SERVICES

A. All fuel, electricity, and internet service shall be paid by the Contractor.

B. The Contractor shall provide maintenance and cleaning once a week for the duration of the project. For a toilet or lavatory, these services shall include, but not limited to, paper towels, toilet paper, and soap.

C. The field office shall be maintained by the Contractor until the work is complete. Earlier removal shall not be done without prior written approval of the Owner. Field office removal and restoration shall be the Contractor’s responsibility.

3.02 SECURITY

A. The Contractor shall be responsible for the security of the field office trailer.

B. The Contractor shall comply with all security requirements specified in Section 01 35 53 – Site Security.

C. The Contractor shall supply Owner 2 sets of door keys for the field office and any other measured used to secure the trailer site.

3.03 LOCATION

A. Field office shall be located to provide access by the Owner and visitors without having to traverse site.

B. Field office shall be located where it will cause as little interference with the work as possible. Relocation of the field office during the course of the project shall be permitted upon written approval of the Owner.

C. Field office location shall be coordinated with and approved by the Owner.

END OF SECTION

SECTION 01 55 00 – SITE ACCESS AND STORAGE

PART 1 -- GENERAL

1.01 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Standards

American National Standards Institute (ANSI)	
ANSI D6.1	Manual on Uniform Traffic Control Devices for Streets and Highways

1.02 HIGHWAY LIMITATIONS

A. The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress to the site of the Work. It shall be the Contractor's responsibility to construct and maintain any haul roads required for its construction operations.

1.03 TEMPORARY CROSSINGS

A. General: Continuous, unobstructed, safe, and adequate pedestrian and vehicular access shall be provided to fire hydrants, commercial and industrial establishments, churches, schools, parking lots, service stations, motels, fire and police stations, and hospitals. Safe and adequate public transportation stops and pedestrian crossings at intervals not exceeding 300-feet shall be provided. The Contractor shall cooperate with parties involved in the delivery of mail and removal of trash and garbage so as to maintain existing schedules for such services. Vehicular access to residential driveways shall be maintained to the property line except when necessary, construction precludes such access for reasonable periods of time.

B. Temporary Bridges: Wherever necessary, to maintain vehicular crossings, the Contractor shall provide suitable temporary bridges or steel plates over unfilled excavations, except in such cases as the Contractor shall secure the written consent of the responsible individuals or authorities to omit such temporary bridges or steel plates, which written consent shall be delivered to the Engineer prior to excavation. Such bridges or steel plates shall be maintained in service until access is provided across the backfilled excavation. Temporary bridges or steel plates for street and highway crossing shall conform to the requirements of the authority having jurisdiction in each case, and the Contractor shall adopt designs furnished by said authority for such bridges or steel plates, or shall submit designs to said authority for approval, as may be required.

C. Street Use: Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work hereunder, and it shall conduct its operations to not interfere unnecessarily with the authorized work of utility companies or other agencies in such streets, alleyways, or parking areas. No street shall be closed to the public without first obtaining permission of the Engineer and proper governmental authority. Where excavation is being performed in primary streets or highways, one lane in each direction shall be kept open to traffic at all times unless otherwise indicated. Toe boards shall be provided to retain excavated material if required by the Engineer or the agency having jurisdiction over the street or highway. Fire hydrants on or adjacent to the Work shall be kept accessible to fire-fighting equipment. Temporary provisions shall be made by the Contractor to assure the use of sidewalks and the proper functioning of gutters, storm drain inlets, and other drainage facilities.

D. Traffic Control: For the protection of traffic in public or private streets and ways, the Contractor shall provide, place, and maintain necessary barricades, traffic cones, warning signs, lights, and other safety devices in accordance with the requirements of the Manual of Uniform Traffic Control Devices, Part VI - Traffic Controls for Street and Highway Construction and Maintenance Operations," published by U.S. Department of Transportation, Federal Highway Administration (ANSI D6.1).

    1. The Contractor shall take necessary precautions for the protection of the Work and the safety of the public. Barricades and obstructions shall be illuminated at night, and lights shall be kept burning from sunset until sunrise. The Contractor shall station such guards or flaggers and shall conform to such special safety regulations relating to traffic control as may be required by the public authorities within their respective jurisdictions. Signs, signals, and barricades shall conform to the requirements of Subpart G, Part 1926, of the OSHA Safety and Health Standards for Construction.

    2. The Contractor shall submit 3 copies of a traffic control plan to the Authority Having Jurisdiction (AHJ) for approval a minimum of 2 weeks prior to construction. The AHJ shall be allowed access to observe these traffic control plans in use and to make any changes as field conditions warrant. Any changes required by the AHJ shall supersede these plans and be done solely at the Contractor's expense.

    3. The Contractor shall remove traffic control devices when no longer needed, repair damage caused by installation of the devices, and shall remove post settings and backfill the resulting holes to match grade.

E. Temporary Street Closure: If closure of any street is required during construction, the Contractor shall apply in writing to the AHJ at least 30 Days in advance of the required closure. A Detour and Traffic Control Plan shall accompany the application.

F. Temporary Driveway Closure: The Contractor shall notify the owner or occupant (if not owner-occupied) of the closure of the driveways to be closed more than one 8 hour work day at least 3 working days prior to the closure. The Contractor shall minimize the inconvenience and minimize the time period that the driveways will be closed. The Contractor shall fully explain to the owner/occupant how long the closure will take and when closure will start.

1.04 CONTRACTOR'S WORK AND STORAGE AREA

A. The Owner will designate and arrange for the Contractor's use, a portion of the property adjacent to the Work for its exclusive use during the term of the Contract as a storage and shop area for its construction operations on the Work. At completion of Work, the Contractor shall return this area to its original condition, including grading and landscaping.

B. The Contractor shall make its own arrangements for any necessary off-Site storage or shop areas necessary for the proper execution of the Work.

1.05 PARKING

A. The Contractor shall:

1. Provide temporary parking areas as follows:

a. 2 spaces for the Owner

b. 2 spaces for the Engineer or Construction Manager

2. Traffic and parking areas shall be maintained in a sound condition, free of excavated material, construction equipment, mud, and construction materials. The Contractor shall repair breaks, potholes, low areas which collect standing water, and other deficiencies.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

01 57 19 TEMPOSECTION 01 57 19 – TEMPORARY ENVIRONMENTAL CONTROLS

PART 1 -- GENERAL

1.01 DUST ABATEMENT

A. The Contractor shall prevent its operation from producing dust in amounts damaging to property, cultivated vegetation, or domestic animals, or causing a nuisance to persons living in or occupying buildings in the vicinity of the Site. The Contractor shall be responsible for any damage resulting from dust originating from its operations. Dust abatement measures shall be continued until the Contractor is relieved of further responsibility by the Engineer.

B. Storage Piles: Enclose, cover, water (as needed), or apply non-toxic soil binders according to manufacturer's specifications on material piles (i.e. gravel, sand, dirt) with a silt content of 5 percent or greater.

C. Active Areas of Site: Water active construction areas and unpaved roads as needed and as requested by Engineer.

D. Inactive Areas of Site: Apply non-toxic soil stabilizers according to manufacturer's specifications to inactive construction areas, or water as needed to maintain adequate dust control.

E. Vehicle Loads: Cover or maintain at least 2-feet of freeboard vertical distance between the top of the load and the top of the trailer sides on trucks hauling dirt, sand, soil, or other loose materials off of the Site.

F. Roads: When there is visible track-out onto a paved public road, install wheel washers where the vehicles exit and enter onto the paved roads and wash the undercarriage of trucks and any equipment leaving the Site on each trip. Sweep the paved street at the end of each shift with mobile water spray pick-up broom-type street sweeper as necessary or as directed.

G. Vehicle Speeds: If watering of unpaved roads is not sufficient to control dust, reduce vehicle speeds to 15 mph or less on such roads.

1.02 SEDIMENTATION ABATEMENT

A. The Contractor shall be responsible for collecting, storing, hauling, and disposing of spoil, silt, and waste materials in compliance with applicable federal, state, and local rules and regulations and the Contract Documents.

B. Install and maintain erosion and sediment control measures, such as swales, grade stabilization structures, berms, dikes, waterways, filter fabric fences, and sediment basins.

C. Filter fabric barrier systems, if used, shall be installed in such a manner that surface runoff will percolate through the system in sheet flow fashion and allow sediment to be retained and accumulated.

D. Remove and dispose of sediment deposits at the designated spoil area. If a spoil area is not indicated, dispose of sediment off-Site at a location not in or adjacent to a stream or floodplain. Sediment to be placed at the spoil area should be spread evenly, compacted, and stabilized. Sediment shall not be allowed to flush into a stream or drainage way.

E. Maintain erosion and sediment control measures until final acceptance or until requested by the Engineer to remove it.

1.03 STORMWATER POLLUTION PREVENTION

A. Contractor shall minimize stormwater pollution from the Site in accordance with the Erosion Control found in the drawings, approved Stormwater Pollution Prevention Plan and Construction Stormwater General Permit

1.04 RUBBISH CONTROL

A. During the progress of the Work, the Contractor shall keep the Site and other areas for which it is responsible in a neat and clean condition and free from any accumulation of rubbish. The Contractor shall dispose of rubbish and waste materials of any nature and shall establish regular intervals of collection and disposal of such materials and waste. The Contractor shall also keep its haul roads free from dirt, rubbish, and unnecessary obstructions resulting from its operations. Disposal of rubbish and surplus materials shall be off the Site in accordance with local codes and ordinances governing locations and methods of disposal and in conformance with applicable safety laws and the particular requirements of Part 1926 of the OSHA Safety and Health Standards for Construction.

1.05 SANITATION

A. Toilet Facilities: Fixed or portable chemical toilets shall be provided wherever needed for the use of employees. Toilets shall conform to the requirements of Part 1926 of the OSHA Standards for Construction.

B. Sanitary and Other Organic Wastes: The Contractor shall establish a regular daily collection of sanitary and organic wastes. Wastes and refuse from sanitary facilities provided by the Contractor or organic material wastes from any other source related to the Contractor's operations shall be disposed of away from the Site in a manner satisfactory to the Engineer and in accordance with Laws and Regulations pertaining thereto.

1.06 CHEMICALS

A. Chemicals used on the Work or furnished for facility operation, whether defoliant, soil sterilant, herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall show approval of either the U.S. Environmental Protection Agency or the U.S. Department of Agriculture. Use of such chemicals and disposal of residues shall be in strict accordance with the printed instructions of the manufacturer. In addition, see the requirements set forth in Article 6 of the General Conditions.

1.07 CULTURAL RESOURCES

A. The Contractor's attention is directed to the National Historic Preservation Act of 1966 (16 U.S.C. 470) and 36 CFR 800 which provides for the preservation of potential historical architectural, archaeological, or cultural resources (hereinafter called "cultural resources").

B. In the event potential cultural resources are discovered during subsurface excavations at the Site, the following procedures shall be instituted:

1. The Owner will issue a temporary Notice to Suspend Work directing the Contractor to cease construction operations at the location of such potential cultural resources find.

2. The suspension Notice will contain the following:

a. A clear description of the Work to be suspended

b. Instructions regarding issuance of further orders by the Contractor for material services

c. Guidance as to the action to be taken on subcontracts

d. Suggestions to the Contractor to minimize incurred costs

e. Estimated duration of the temporary suspension.

3. Such suspension shall be effective until such time as a qualified archeologist can assess the value of the potential cultural resources and make recommendations to the Department of Archaeology & Historic Preservation (DAHP).

4. The Owner will implement appropriate actions as directed by DAHP or the Project Manager. The Contractor shall cease Work in the area of a discovery until appropriate actions have been determined in accordance with this paragraph.

5. If human remains are discovered, Work in the immediate vicinity of the find shall stop. The County Coroner shall be notified.

C. If the archeologist determines that the potential find is a bonafide cultural resource, at the direction of DAHP, the Owner will extend the duration of the suspension.

D. Changes to the Contract Price and Contract Times for suspension due to discovery of a potential cultural resource will be made in the following manner:

1. Contract Times

a. If the Work temporarily suspended is on the “critical path”, the total number of Days for which the suspension is in effect will be added to the Contract Times.

b. If a portion of Work at the time of such suspension is not on the “critical path”, but subsequently becomes Work on the critical path, the Contract Times will be computed from the date such Work is classified as on the critical path.

2. Contract Price

    a. If, as a result of a cultural resources suspension, the Contractor sustains a loss that could not have been avoided by judicious handling of forces and equipment or redirection of forces or equipment to perform other Work on the contract, there will be paid an amount based on time and materials for the loss in accordance with the following:

        1) Idle Time of Equipment: Compensation for equipment idle time will be determined in accordance with the General Conditions for equipment time and equipment rental time.

        2) Idle Time of Labor: Compensation for idle time of workers will be determined in accordance with the General Conditions for labor.

    b. Costs of labor will be compensated only to the extent such cost was in fact caused by the suspension.

    c. Compensation for loss due to idle time of either equipment or labor will not include markup for profit.

    d. The hours for which compensation will be paid will be the actual normal working time during which such suspension lasts but will in no case exceed eight hours in any single Day.

    e. The days for which compensation will be paid exclude Saturdays, Sundays, and legal holidays during the suspension.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 58 13 – PROJECT SIGNAGE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide and install one project identification sign, complete, in accordance with the Contract Documents.

B. The Owner will obtain a sign permit, if one is required, at no cost to the Contractor.

PART 2 -- PRODUCTS

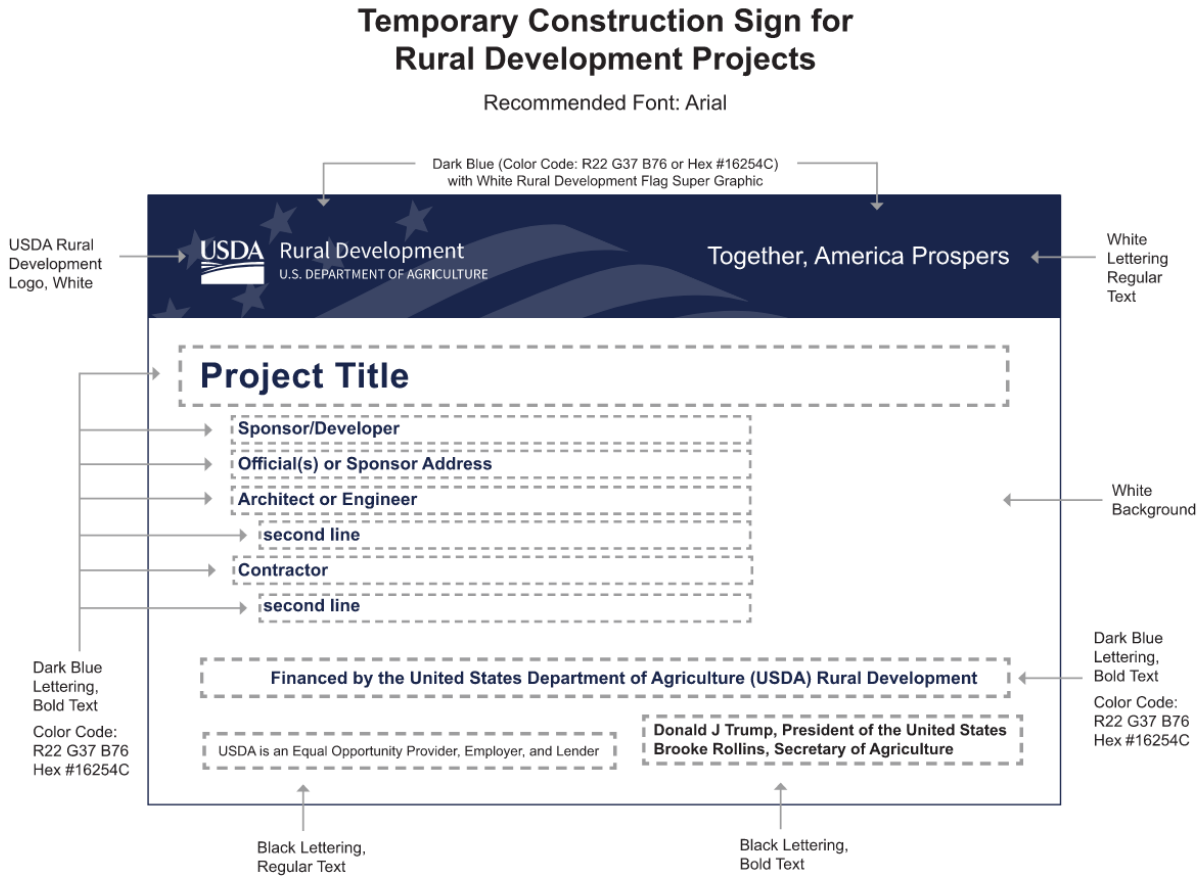
2.01 SIGN CONSTRUCTION

A. The sign shall be constructed of 3/4-inch plywood with 4-inch by 4-inch supports and 2-inch by 4-inch cross bracing.

B. The sign face shall be 4-feet vertical by 8-feet horizontal.

SIGN CONTENT

C. Sign content shall be:



SIGN DIMENSIONS: 1200mm x 2400mm x 19mm (approx.4' x 8' x 3/4)
PLYWOOD PANEL (APA RATED A+B GRADE-EXTERIOR)

PART 3 -- EXECUTION

3.01 SIGN LOCATION

A. The project sign shall be located on the Site as directed by the Owner.

B. The sign shall be set 4-feet above the ground, measured from grade to the lower edge of the plywood sheet.

3.02 REMOVAL

A. Remove the project sign upon preparation of the Notice of Completion.

END OF SECTION

SECTION 01 60 00 – PRODUCTS, MATERIALS, EQUIPMENT, AND SUBSTITUTIONS

PART 1 -- GENERAL

1.01 DEFINITIONS

A. The word "Products," as used in the Contract Documents, is defined to include purchased items for incorporation into the Work, regardless of whether specifically purchased for the project or taken from Contractor's stock of previously purchased products. The word "Materials," is defined as products which must be substantially cut, shaped, worked, mixed, finished, refined, or otherwise fabricated, processed, installed, or applied to form Work. The word "Equipment" is defined as products with operational parts, regardless of whether motorized or manually operated, and particularly including products with service connections (wiring, piping, and other like items). Definitions in this paragraph are not intended to negate the meaning of other terms used in the Contract Documents, including "specialties," "systems," "structure," "finishes," "accessories," "furnishings," special construction," and similar terms, which are self-explanatory and have recognized meanings in the construction industry.

B. Neither "Products" nor "Materials" nor "Equipment" includes machinery and equipment used for preparation, fabrication, conveying, and erection of the Work.

1.02 QUALITY ASSURANCE

A. Source Limitations: To the greatest extent possible for each unit of Work, the Contractor shall provide products, materials, and equipment of a singular generic kind from a single source.

B. Compatibility of Options: Where more than one choice is available as options for Contractor's selection of a product, material, or equipment, the Contractor shall select an option which is compatible with other products, materials, or equipment. Compatibility is a basic general requirement of product, material and equipment selections.

1.03 PRODUCT DELIVERY AND STORAGE

A. The Contractor shall deliver and store the Work in accordance with manufacturer's written recommendations and by methods and means which will prevent damage, deterioration, and loss including theft. Delivery schedules shall be controlled to minimize long-term storage of products at the Site and overcrowding of construction spaces. In particular, the Contractor shall ensure coordination to ensure minimum holding or storage times for flammable, hazardous, easily damaged, or sensitive materials to deterioration, theft, and other sources of loss.

1.04 TRANSPORTATION AND HANDLING

A. Products shall be transported by methods to avoid damage and shall be delivered in undamaged condition in manufacturer's unopened containers and packaging.

B. The Contractor shall provide equipment and personnel to handle products, materials, and equipment including those furnished by Owner, by methods to prevent soiling and damage.

C. The Contractor shall provide additional protection during handling to prevent marring and otherwise damaging products, packaging, and surrounding surfaces.

1.05 STORAGE AND PROTECTION

A. Products shall be stored in accordance with manufacturer's written instructions and with seals and labels intact and legible. Sensitive products shall be stored in weather-tight climate controlled enclosures and temperature and humidity ranges shall be maintained within tolerances required by manufacturer's recommendations.

B. For exterior storage of fabricated products, products shall be placed on sloped supports above ground. Products subject to deterioration shall be covered with impervious sheet covering and ventilation shall be provided to avoid condensation.

C. Loose granular materials shall be stored on solid flat surfaces in a well-drained area and shall be prevented from mixing with foreign matter.

D. Storage shall be arranged to provide access for inspection. The Contractor shall periodically inspect to assure products are undamaged and are maintained under required conditions.

E. Storage shall be arranged in a manner to provide access for maintenance of stored items and for inspection.

1.06 MAINTENANCE OF PRODUCTS IN STORAGE

A. Stored products shall be periodically inspected on a scheduled basis. The Contractor shall maintain a log of inspections and shall make the log available on request.

B. The Contractor shall comply with manufacturer's product storage requirements and recommendations.

C. The Contractor shall maintain manufacturer-required environmental conditions continuously.

D. The Contractor shall ensure that surfaces of products exposed to the elements are not adversely affected and that weathering of finishes does not occur.

E. For mechanical and electrical equipment, the Contractor shall provide a copy of the manufacturer's service instructions with each item and the exterior of the package shall contain notice that instructions are included.

F. Products shall be serviced on a regularly scheduled basis, and a log of services shall be maintained and submitted as a record document prior to final acceptance by the Owner in accordance with the Contract Documents.

1.07 PROPOSED SUBSTITUTIONS OR "OR-EQUAL" ITEM

A. Whenever materials or equipment are indicated in the Contract Documents by using the name of a proprietary item or the name of a particular manufacturer, the naming of the item is intended to establish the type, function, and quality required. If the name is followed by the words "or equal" indicating that a substitution is permitted, materials or equipment of other manufacturers may be accepted if sufficient information is submitted by the Contractor to allow the Engineer to determine that the material or equipment proposed is equivalent or equal to that named, subject to the following requirements:

   1. The burden of proof as to the type, function, and quality of any such substitution product, material or equipment shall be upon the Contractor. The Contractor shall provide the Owner with an agreed upon credit prior to evaluation of an “or equal” item.

   2. The Engineer will be the sole judge as to the type, function, and quality of any such substitution and the Engineer's decision shall be final.

   3. The Engineer may require the Contractor to furnish additional data about the proposed substitution.

   4. The Owner may require the Contractor to furnish a special performance guarantee or other surety with respect to any substitution.

   5. Acceptance by the Engineer of a substitution item proposed by the Contractor shall not relieve the Contractor of the responsibility for full compliance with the Contract Documents and for adequacy of the substitution.

   6. The Contractor shall pay all costs, of implementing accepted substitutions, including redesign and changes to Work necessary to accommodate the substitution. If the Engineer is required to provide redesign, payment shall be agreed upon prior to redesign efforts.

B. The procedure for review by the Engineer will include the following:

   1. If the Contractor wishes to provide a substitution item, the Contractor shall make written application to the Engineer on the "Substitution Request Form."

   2. Unless otherwise provided by law or authorized in writing by the Engineer, the "Substitution Request Form(s)" shall be submitted within the 35-day period after award of the Contract.

   3. Wherever a proposed substitution item has not been submitted within said 35-day period, or wherever the submission of a proposed substitution material or equipment has been judged to be unacceptable by the Engineer, the Contractor shall provide the material or equipment indicated in the Contract Documents.

   4. The Contractor shall certify by signing the form that the list of paragraphs on the form are correct for the proposed substitution.

   5. The Engineer will evaluate each proposed substitution within a reasonable period of time.

6. As applicable, no shop drawing submittals shall be made for a substitution item nor shall any substitution item be ordered, installed, or utilized without the Engineer's prior written acceptance of the Contractor's "Substitution Request Form."

7. The Engineer will record the time required by the Engineer in evaluating substitutions proposed by the Contractor and in making changes by the Contractor in the Contract Documents occasioned thereby.

C. The Contractor's application shall address the following factors which will be considered by the Engineer in evaluating the proposed substitution:

1. Whether the evaluation and acceptance of the proposed substitution will prejudice the Contractor's achievement of Substantial Completion on time.

2. Whether acceptance of the substitution for use in the Work will require a change in any of the Contract Documents to adapt the design to the proposed substitution.

3. Whether incorporation or use of the substitution in connection with the Work is subject to payment of any license fee or royalty.

4. Whether all variations of the proposed substitution from the items originally specified are identified.

5. Whether available maintenance, repair, and replacement service are indicated. The manufacturer shall have a local service agency (within 50 miles of the site) which maintains properly trained personnel and adequate spare parts and is able to respond and complete repairs within 24 hours.

6. Whether an itemized estimate is included of all costs that will result directly or indirectly from acceptance of such substitution, including cost of redesign and claims of other contractors affected by the resulting change.

7. Whether the proposed substitute item meets or exceeds the experience and/or equivalency requirements listed in the appropriate technical specifications.

D. Without any increase in cost to the Owner, the Contractor shall be responsible for and pay all costs in connection with proposed substitutions and of inspections and testing of equipment or materials submitted for review prior to the Contractor's purchase thereof for incorporation in the Work, whether or not the Engineer accepts the proposed substitution or proposed equipment or material. The Contractor shall reimburse the Owner for the charges of the Engineer for evaluating each proposed substitution.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 62 00 - INSTALLATION OF MEMBRANE EQUIPMENT

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Seller shall coordinate all services and activities required by this section with the Buyer, Contractor, and the Engineer.

1. Upon completion of installation, the Engineer shall issue a “Notice of Completed Installation”.

B. Reference Specifications:

1. Section 01 66 00 - Commissioning of Membrane Equipment

2. Section 01 73 00 - Installation, Operation, and Maintenance Manuals

3. Section 46 61 34 - Containerized Membrane Filtration System

1.02 QUALITY CONTROL/QUALITY ASSURANCE (QA/QC) - NOT USED

1.03 SUBMITTALS

A. Pre-Delivery Submittals

1. The Seller shall provide to the Contractor a listing of Goods to be transported to the Point of Destination.

2. Seller shall provide to the Contractor a listing of Goods that require protection. Special storage, protection, and handling instructions shall be provided for these items.

3. In accordance with Section 01 73 00 - Installation, Operation and Maintenance Manuals shall be provided.

PART 2 -- PRODUCTS – (NOT USED)

PART 3 -- EXECUTION

3.01 INSTALLATION

A. The Seller shall provide training to the Contractor for installation of membrane equipment. The training shall be conducted on-site by an authorized, experienced, employee of the Seller.

B. An employee of the Seller shall be present to oversee the assembly installation of the associated anchor bolts for Seller-furnished equipment.

C. Seller shall be responsible for identification of the volume and concentration of the membrane module storage solution and rinsing requirements for the membrane modules.

D. Contractor shall be responsible for making adjustments and/or modifications to the installation process that may become necessary to ensure that the equipment is properly installed.

E. After the installation is complete, the Seller, Contractor, and Engineer shall jointly perform a pre-commissioning inspection of the containerized membrane system. The inspection shall identify the following:

1. Mechanical

    a. Containerized Membrane units shall be completely installed and unit and interconnecting piping pressure tested.

    b. The Process Air System piping supplying pressurized air from the containerized membrane units to the neutralization system, citric acid system, sodium hydroxide system, sodium hypochlorite system, and calcium thiosulfate system system shall be completely installed and the piping pressure tested.

2. Electrical

    a. All local control panels shall be installed and terminations completed.

    b. All 480V, 120V, and 24VDC power supplies shall be connected and verified.

    c. The documentation associated with the inspection of electrical terminations shall be provided by the Contractor to the Seller.

F. Contractor shall be responsible for making adjustments and/or modifications to the installation process that may become necessary to ensure that all equipment is properly installed.

1. The inspection shall identify equipment that has not been properly installed, detailing the outstanding installation issues on a “punch list”, and noting the party who shall be responsible for each correction and identify the items that require correction before commissioning can begin.

2. Once the corrections identified have been made, a “Notice of Completed Installation” shall be issued by the Engineer and commissioning shall commence in accordance with the requirements of Section 01 66 00 - Commissioning of Membrane Equipment.

END OF SECTION

SECTION 01 64 00 – PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 -- GENERAL

1.01 REQUIREMENTS INCLUDED

A. Providing secure storage and protection for products to be incorporated into the Work, and maintaining and protecting products after installation and until completion of the Work.

1.02 STORAGE

A. Store and protect products immediately on delivery. Store in accordance with manufacturer's instructions, with seals and labels intact and legible.

B. Store products subject to damage by elements in substantial weather tight enclosures.

1. Maintain temperatures within ranges required by manufacturer's instructions.

2. Provide humidity control for sensitive products, as required by manufacturer's instructions.

3. Store unpacked products on shelves, in bins or in neat piles, accessible for inspection.

C. Exterior Storage:

1. Provide substantial platforms, blocking or skids to support fabricated products above ground and to prevent soiling or staining. Cover products subject to discoloration or deterioration from exposure to the elements, with impervious sheet coverings. Provide adequate ventilation to avoid condensation.

2. Store loose granular materials on solid surfaces such as paved areas or provide plywood or sheet materials to prevent mixing with foreign matter.

a. Provide surface drainage to prevent flow or ponding of rainwater.

b. Prevent mixing of refuse or chemically injurious materials or liquids.

D. Arrange storage in manner to provide easy access for inspection.

1.03 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on scheduled basis to assure that:

1. State of storage facilities is adequate to provide required conditions.

2. Required environmental conditions are maintained on continuing basis.

3. Surfaces of products exposed to elements are not adversely affected. Any weathering of products, coatings and finishes is unacceptable under requirements of Contract Documents.

B. Mechanical and electrical equipment which requires servicing during long term storage shall have complete manufacturer's instructions for servicing accompanying each item, with notice of enclosed instructions shown on exterior of package. Comply with manufacturer's instructions on scheduled basis.

C. Any product damaged because of improper storage or protection shall be unacceptable for installation and shall be removed from the site.

1.04 PROTECTION AFTER INSTALLATION

A. Provide protection of installed products to prevent damage from subsequent operations. Remove protection when no longer needed, prior to completion of Work.

B. Control traffic to prevent damage to equipment and surfaces.

C. Provide coverings to protect finished surfaces from damage.

1. Cover projections, wall corners, and jambs, sills and soffits of openings, in areas used for traffic and for passage of products in subsequent work.

2. Protect finished floors and stairs from dirt and damage:

a. In areas subject to foot traffic, secure heavy paper, sheet goods, or other materials in place.

b. Lay planking or similar materials in place to support movement of heavy products.

c. Store products on wood sheathing.

d. Cover walls and floor of elevator cars, and surfaces of elevator car doors, used by construction personnel.

D. Waterproofed surfaces and roofs.

1. Prohibit use of surfaces for traffic of any kind, and for storage of any products.

2. When some activity must take place in order to carry out the Contract, obtain recommendations of installer for protection of surface.

a. Install recommended protection, remove on completion of that activity.

b. Restrict use of adjacent unprotected areas.

E. Lawns and Landscaping: Prohibit traffic of any kind across planted lawn and landscaped areas.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 66 00 - COMMISSIONING OF MEMBRANE EQUIPMENT

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work: The Seller shall commission the membrane equipment and place the system into operation. Commissioning is subject to the following provisions:

1. Commissioning shall not commence until the “Notice of Completed Installation” is issued in accordance with Section 01 62 00 - Installation of Membrane Equipment.

2. Commissioning shall be completed by the Seller within the allocated time as identified in the Agreement.

3. The Engineer shall document the time when the facilities are substantially unavailable for use by the Seller to perform commissioning. Potential times of substantial unavailability include: 1) when the installation of membrane modules results in a delay to the Seller, 2) when the Engineer conducts its review of system operation and 3) circumstances beyond the control of the Seller including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the Seller, not having adequate staff from the Contractor or the Buyer. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Seller, equivalent additional commissioning time will be granted.

4. Failure to complete the Commissioning as required by this Section within the allocated time shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until commissioning is complete.

5. Upon completion of Commissioning, the Engineer shall issue the “Notice of Completed Commissioning.”

B. The Seller shall coordinate all services and activities required by this Section with the Contractor, the Engineer and the Buyer. These activities shall be coordinated with the requirements of Section 40 91 00 - Process Control Instrumentation Systems.

C. The Seller shall perform all other tests required by the Specifications.

D. Reference Specifications:

1. Section 01 73 10 - Training of Operations and Maintenance Personnel

2. Section 46 61 34 - Containerized Membrane Filtration System

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC) - NOT USED

1.03 SUBMITTALS

A. The Seller shall prepare a “Detailed Plan of Commissioning Activities” that will be used as a guideline for Commissioning of the Goods provided by the Seller. The Detailed Plan of Commissioning Activities shall be used to coordinate the activities of the Seller’s personnel. The “Detailed Plan of Commissioning Activities” will identify the Commissioning requirements for all Goods supplied by the Seller. The guidelines shall include the following minimum check items.

1. Pump(s), Metering Pumps, Blowers, Compressors and Other Rotating Equipment

    a. Filled with Oil

    b. Rotation is Proper

    c. Aligned Properly (Mechanical Seal has been set)

    d. Receives and responds to Process Control Command Signals (Discrete and/or Analog)

2. Instruments (Flow, Pressure, Level, Temperature and Analytical)

    a. Electrical Supply is Connected

    b. Software is Configured

    c. Responds to Position and Sends Discrete and Analog Signals

    d. Control Alarm Set Point has been established

    e. Instrument is calibrated

3. Switches (Flow, Pressure, Level and Temperature)

    a. Electrical Supply is Connected

    b. Sends Signal Upon Transition of State

    c. Are Calibrated

4. Automated Modulating Valves

    a. Air and/or Electrical Supply is Connected

    b. Responds to Position and Sends Feedback Signals

    c. Control Alarm Set Point has been established

5. Manual and Automatic Valves

    a. Air and/or Electrical Supply is Connected

b. Responds to and sends Feedback (Limit Switch) Signals

B. The “Detailed Plan of Commissioning Activities” will be used as a guideline for placing the facility into operation. The “Detailed Plan of Commissioning Activities” shall be coordinated with the activities of the Contractor, the Engineer and the Buyer. The guidelines shall include the following minimum check items.

1. Field Verification of Installed Equipment including:

a. Pumps, Compressors, Blowers, Tankage

b. Piping Systems and Temporary Connections

c. Electrical Control and Operator Interface Systems

2. Commissioning of Equipment

a. Feed Pumps, Filtrate Pumps (vacuum system), Vacuum Pumps, Metering Pumps, Compressors, Blowers

b. Switches, Transmitters, Analyzers

c. Modulating Manual and Automated Valves

3. Start-up Activities

a. Feed, Filtered Water and Backwash Flow Pressure and Level Control Sequences

b. Membrane Treatment Unit Operations including filtration, backwashing clean in place and membrane integrity testing.

c. Normal and Emergency Start Up and Shut Down Sequences.

d. Process Interlocks

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 COMMISSIONING

A. No system or subsystem shall be started-up for continuous operation unless all Goods, including instrumentation and monitoring systems, of that system or subsystem have been tested and proven to be operable as intended by the Contract Documents.

B. The Seller shall place the Goods into operation and perform tests to determine if equipment is operating properly. The purpose of these tests is to verify that both the System and each Unit are:

1. Properly installed

2. Operational

3. Capable of completing an operating cycles free of problems

4. Free from pump or valve cavitation, water hammer, overheating, overloading, vibration, or other operating problems.

5. The Seller shall verify that control programming has been configured with appropriate software time delays to avoid rapid pump or membrane flow cycling in response to transient dynamic hydraulic effects caused by backwash, or chemical washing cycles or other process cycles (e.g. start - up, shut down, membrane test). “Dead-heading” or any operation of any pump under a “zero-flow” or “flow condition below the pump manufacturers acceptable limits” is not acceptable. Interlocks shall be provided to prevent operation of the any pump under a “dead-headed” condition. The pump manufacturers “maximum number of pumps starts per hour” shall not be exceeded.

C. The Seller shall coordinate all activities with the Contractor, Buyer and Engineer. The types of activities to be performed by the Seller will be detailed in the “Detailed Plan of Commissioning Activities” include but not necessarily limited to the following items:

1. Initial Start Up Activities

   a. Verify Unit and Piping Installation

   b. Verify Valve Tags

   c. Verify temporary system interconnections

   d. Verify Instrumentation and Control

      1) Verify Fiber Optic System

      2) Verify PLC Communication

      3) Verify PC or Operator Interface Communication

2. Commissioning Activities

   a. Verify Pumps for Rotation

   b. Commission Compressed Air System

   c. Commission Blower System

   d. Test Modulating Valves

   e. Test Chemical Feed Systems used for feed and backwash

   f. Test Chemical Feed Systems used in Clean-In-Place

   g. Test Level Switches in Tanks

   h. Test Pressure Switches

i. Set Mechanical Seals in Pumps and Flush System

j. Test and Calibrate Process Instruments

1) Flow Meters

2) Pressure Transmitters

3) Level Transmitters

4) Turbidity Meters

5) Chlorine Residual Analyzers

6) pH/ORP Meters

7) Conductivity Meters

8) Temperature Transmitters

k. Miscellaneous Equipment

l. Field Located Manual Valves

m. Field Located Automatic Valves

n. Manual Unit Valves

o. Automatic Unit Valves

p. Flush Piping Systems

3. Start Up Activities

a. Complete Operational Readiness Test (ORT)

b. Feed Flow / Pressure / Level Control System in Manual the Automatic Mode

c. Filtrate Pressure Flow / Pressure / Level Control System in Manual the Automatic Mode

d. Backwash Flow / Pressure Level / Control System in Manual the Automatic Mode

e. Backwash Process Residuals Flow / Pressure Level / Control System in Manual the Automatic Mode

f. Filtration Units Placed into Service in Manual the Automatic Mode

g. Check Start Up Sequence in Normal and Emergency Modes

h. Check Shut Down Sequence in Normal and Emergency Modes

i. Check Process Logic Interlocks

j. Remove Temporary Interconnections

k. Disinfect Piping (if applicable)

l. Install Membrane Modules

m. Place Membrane System in Operation

1) Verify Filtration Sequence

2) Verify Backwash Sequence

3) Verify Membrane Test Sequence

4) Verify Other Seller Process Sequences

n. Chemically Clean Membrane Units

o. Perform Functional Acceptance Test

D. As a part of the commissioning, the Seller shall start-up and operate all support systems provided by or required by the Seller for operation of the system, including but not limited to chemical feed systems, instrumentation, air compression equipment, and electric controls. This testing shall demonstrate that there are no water or air leaks in the System, that the piping has been installed and connected properly, that the electrical system is operating correctly, and that the instrumentation has been properly calibrated.

E. The Seller shall furnish materials (excluding chemicals and power), instruments, and incidental and expendable equipment required for commissioning / placing the equipment into operation. The Seller shall retain the services of any manufacturers representatives as required in the Contract Documents to assist with the commissioning / placing into operation of the Goods. The costs of these services shall be borne by the Seller

F. The Seller shall oversee the installation the membrane modules by the Contractor. The location and serial number of each membrane module shall be provided using a Microsoft Excel Spreadsheet. This information will be used to document Membrane Warranty replacement. Membrane module information shall be collated and submitted to the Buyer as part of the Commissioning Test Reports Manual.

G. Once the membrane modules have been installed, the Seller shall conduct a membrane integrity test on each Unit. The Seller shall provide the Engineer with both the integrity test results for each Unit and results documenting that each installed Unit has passed the integrity test. The Seller shall repair or replace any defective membranes.

H. When requested by the Seller, the Engineer shall review the operation of the equipment to verify that the commissioning is complete.

1. The Engineer shall perform random tests to determine if the equipment is operating properly and witness various operational sequences.

2. Perform and review the results of the Functional Acceptance Test (FAT)

3. The Engineer may initiate alarm conditions to determine if the control system is functioning properly.

4. The Engineers review shall include a review of the HMI interface and PLC SCADA system commissioning requirements

5. The Engineers review shall identify any equipment that has not been properly installed, or operating, detailing the outstanding installation issues on a “punch list” and noting the party who shall be responsible for each correction and identify the items require that correction.

I. Upon satisfactory completion of the review, the Engineer shall submit to the Seller a written “Notice of Completed Commissioning”.

J. Once the “Notice of Completed Commissioning” is issued, Training of Operation and Maintenance Personnel may commence. Refer to Section 01 73 10 - Training of Operations and Maintenance Personnel.

END OF SECTION

SECTION 01 67 00 ACCEPTANCE TESTING OF MEMBRANE EQUIPMENT

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work: The Seller shall perform an Acceptance Testing of the membrane equipment. Acceptance Testing is subject to the following provisions.

1. Acceptance Testing shall not commence until the Notice of Completed Training is issued in accordance with Section 01 73 10 - Training of Operations and Maintenance Personnel.

2. Acceptance Testing shall commence within 7 days after completion of training or at a mutually agreed upon time by the Seller, Buyer, Contractor, and Engineer.

3. Acceptance Testing shall extend for a period of 30 consecutive days.

4. Acceptance Testing shall be completed by the Seller within the allocated time identified in the Agreement.

5. Failure to complete the Acceptance Testing as required by this Section within the allocated time shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until Acceptance Testing is complete.

6. The Engineer shall document the time when the facilities are substantially unavailable for use by the Seller to perform Acceptance Testing due to circumstances beyond the control of the Seller including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the Seller, not having adequate staff from the Contractor or the Buyer. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Seller, equivalent additional Acceptance Testing time will be granted.

7. The date that the Acceptance Testing ends shall be used by the Engineer for the date of the membrane equipment “Notice of Substantial Completion”. The “Notice of Substantial Completion” shall be issued by the Engineer upon completion of FINAL Operational and Maintenance Manuals.

B. Reference Specifications

1. Section 01 73 10 - Training of Operations and Maintenance Personnel

2. Section 46 61 34 - Containerized Membrane Filtration System

C. Coordination

1. The Seller shall coordinate all services and activities required by this Section with the Contractor, Buyer and the Engineer.

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC) - NOT USED

1.03 SUBMITTALS

A. Upon completion of the Acceptance Testing, the Seller shall submit to the Buyer a written report detailing the results of the Acceptance Testing, including a copy of all field notes and test data.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 ACCEPTANCE TESTING

A. Upon completion of the Operator Training in accordance with the requirements of Section 01 73 10 - Training of Operational and Maintenance Personnel, the Seller shall perform an Acceptance Test on the System.

B. The purpose of the Acceptance Testing is to demonstrate that equipment is:

1. Properly installed

2. Ready to be placed into service by the Buyer

3. In compliance with the service conditions, performance requirements, material specifications, and all other requirements of the Contract Documents

4. In compliance with the requirements of Instrumentation and Control System Testing (Reliability Acceptance Test, (RAT)).

C. The Seller shall furnish all materials, instruments, and incidental and expendable equipment required for Acceptance Testing, except where otherwise specified.

D. Throughout the Acceptance Testing period, a representative of the Seller shall be present on site during normal working hours and available via means of a pager or cellular communication during non-working hours in case of an emergency.

E. The Buyer or an authorized representative of the Buyer will be present to witness the Acceptance Testing.

F. The Seller shall keep detailed notes regarding the Acceptance Testing and record all test data and results. This will be done through operation of the data logging system. Upon successful completion of the Acceptance Testing, the Seller shall submit a written report on the Acceptance Testing, as specified in Paragraph 1.03.A of this Section.

G. The initial Acceptance Testing period will extend for 30 consecutive days with one or more Unit(s) per train of units operate at the design flow, with the other Units are equally balanced to treat the remaining raw water available for the 30- day period.

H. After the Acceptance Testing is completed, the Engineer and Buyer will meet with the Seller to determine compliance with the Contract Documents. At that time, if it is determined that the Seller has fulfilled the requirements of the Contract Documents, the Seller will be released from its on-site obligation unless otherwise retained.

I. If the Units do not meet the criteria of linear scalability as defined in the Agreement, or if the System does not perform in accordance with the Contract Documents, the Seller shall return or remain on site to perform all necessary corrections at the cost of the Seller until compliance with Contract Documents is demonstrated.

J. During the Acceptance Testing, the System shall perform in accordance with the guaranteed product water quality to allow the Buyer to discharge treated water.

K. If the Acceptance Testing is interrupted at the request of the Seller or by the non-conformance of the Seller's equipment for more than three instances or a cumulative downtime of more than six hours during the acceptance test, the Buyer or Engineer may require that Acceptance Testing be restarted from the beginning, at no cost to the Buyer.

L. Any interruption of the Acceptance Testing caused by circumstances beyond the control of the Seller shall not require the testing to be restarted from the beginning. Such events include any activities that would result in an inadvertent or unplanned shutdown of the PLC / HMI control System or otherwise interfere with the Reliability Acceptance Test. The elapsed time of Acceptance Testing prior to the interruption will be applied to the required testing period.

END OF SECTION

SECTION 01 71 13– MOBILIZATION

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Contractor shall mobilize as required for the proper performance and completion of the Work and in accordance with the Contract Documents.

B. Mobilization shall include at least the following items:

1. Moving equipment necessary for the first month of operation to the work site.

2. Installing temporary construction power, wiring, internet and lighting facilities.

3. Establishing a fire protection system.

4. Developing construction water supply.

5. Providing field offices for the Contractor and the Engineer, complete with furnishings, equipment, and utility services.

6. Providing on-Site sanitary facilities and potable water facilities.

7. Arranging for and erection of Contractor's Work and storage yards.

8. Constructing and implementing security features and requirements complying with Section 01 35 53 – Site Security.

9. Obtaining required permits.

10. Having OSHA required notices and establishing safety programs.

11. Having the Contractor's superintendent at the Site full time.

12. Submitting initial submittals.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 35 53	Site Security
01 51 00	Temporary Utilities
01 52 00	Field Office, Equipment and Services
01 55 00	Site Access and Storage
01 57 19	Temporary Environmental Controls

1.03 PAYMENT FOR MOBILIZATION

A. The Contractor's attention is directed to the condition that 5 percent of the Contract Price will be deducted from any money due the Contractor as progress payments until mobilization items listed above have been completed. The aforementioned amount will be retained by the Owner as the agreed, estimated value of completing the mobilization items listed. Any such retention of money for failure to complete such mobilization items shall be in addition to the retention from any payments due to the Contractor in accordance with Article 14 of the General Conditions.

B. As soon as practicable after receipt of the Notice to Proceed, the Contractor shall submit a breakdown to the Engineer for approval, which shall show the estimated value of each major component of mobilization. When approved by the Engineer, the breakdown will be the basis for initial progress payments in which mobilization is included.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 73 00 INSTALLATION, OPERATION AND MAINTENANCE MANUALS

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work:

1. Provide INSTALLATION, PRELIMINARY and FINAL Operational and Maintenance (O&M) Manuals for use by the Contractor and the Buyer.

a. The term "Operation and Maintenance Manual" includes all product related information and documents which are required for preparation of the Membrane Filtration System O&M Manual, and data that is required for inclusion by current regulations of any participating government agency or as a provision of a membrane system warranty.

b. Failure to provide the INSTALLATION, PRELIMINARY and FINAL Operational and Maintenance (O&M) Manuals as required by this Section within the allocated time shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until Manuals have been received. Required Delivery for O&M Manuals are as follows:

1) INSTALLATION Manuals are due 30 days before the Goods are delivered to the Point of Destination.

2) PRELIMINARY O&M Manuals are due 30 days before Commissioning.

3) FINAL O&M Manuals are due 30 days after the completion of Acceptance Testing.

c. The term component equipment supplier is used to describe a manufacturer’s Goods purchased by the Seller and incorporated into the Membrane Filtration System.

d. The O&M Manual shall include, but not be limited to, the following:

1) Equipment function, operating characteristics, limiting conditions, operating instructions and procedures for startup, normal and emergency conditions, shutdown and storage

2) Safety considerations relating to installation, operation and maintenance procedures

3) Installation procedures

4) Calibration procedures

5) Routine and preventive maintenance instructions

6) Procedures for disassembly, reassembly, alignment, adjustment, and inspection instructions

7) Recommended spare parts list to maintain equipment in service

8) Special Tools:

   a) For Seller equipment, provide list of special tools included and required for installation checking, testing, parts replacement, and maintenance

   b) For component equipment, a list of special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance with current price information

9) For component equipment provide name, address and telephone number for local sources of equipment and/or replacement parts

10) Operational log sheets and maintenance schedules

11) Material Safety Data Sheets (MSDSs) for any applicable item (chemicals, oils, lubricants, etc) provided by the Seller

12) Furnish lubricants of the type and grade necessary to meet the requirements of the equipment. Provide lubricants that are NSF Standard 61 approved as food grade and that are compatible for use in public water supplies

13) Warranty Information, Bond(s), and Service contract(s), if applicable

14) Equipment Specific and Factory Test Report information shall include:

   a) Tag name, Model and Serial number of the equipment provided

   b) Name, address, and phone number of manufacturer, manufacturer's local service representative

   c) Factory Test Reports where applicable

   d) Approved Shop Drawings (including equipment drawings, schematics, circuit diagrams)

e. Routine and preventive maintenance instructions include all information and instructions required to keep equipment properly lubricated, adjusted, and maintained so that the item functions as intended throughout its full design life. Routine and preventive maintenance instructions shall include, but not be limited to, the following:

   1) Written explanations with illustrations for each preventive maintenance task

   2) Recommended schedule for execution of preventive maintenance tasks

   3) Lubrication charts shall include a table of alternative lubricants naming at least two alternate lubricant manufacturers, with applicable product numbers, for each application

   4) Troubleshooting instructions

5) List of required maintenance tools and equipment

B. Reference Specifications

1. Section 46 61 34 - Containerized Membrane Filtration System

C. Coordination

1. The Seller shall coordinate the delivery and incorporation of O&M Manuals prepared for this project by the Seller or provided from their component equipment suppliers. The Seller shall develop an O&M Manual for the equipment and systems designed and provided by the Seller under this contract.

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC))

1.03 SUBMITTALS

A. General

1. Installation, Commissioning, Training of any process, or piece of equipment shall not be permitted until the respective INSTALLATION or PRELIMINARY manuals have been received and approved by the Engineer as being sufficient in content to allow the completion of the work.

2. O&M Manuals shall be submitted in three ring binders with a table of contents and index tabs to identify the various items.

3. The table of contents shall reference the applicable specification section(s) for each item and shall be included in each volume of multi-volume manuals.

4. O&M manuals shall use dividers and indexed tabs between major categories of information such as Operating Instructions, Preventive Maintenance Instructions, etc.

5. O&M manuals shall use 8-1/2-inch by 11-inch acid free paper of high rag content and quality. All text must be legible, type-written or machine printed originals or high quality copies.

6. Each page shall have a binding margin of approximately 1-1/2 inches and be punched for placement in a three-ring " D" style loose-leaf binder, which shall be provided by the Seller along with the submittal. Each binder shall be no more than 3 inches.

7. Drawings: Provide full size blueprints (24 x 36) and Half-size black line (11 x 17) reproductions shall be provided for all project drawings. 11-inch x 17- inch drawings shall be bound in a separate binder. 11-inch x 17-inch drawings shall not be folded and placed in any project binder designed for 8½ inch x 11 inch pages.

8. Electronic File Format

a. All Seller O&M Manual information shall be supplied to the Buyer as electronic file format that it was originally developed and in condensed portable document format (.PDF format). The specifications for PDF generation are as follows:

1) The acceptable format is Portable Document Format (PDF): Adobe Acrobat or Adobe Acrobat Exchange

2) The initial filename for the EOM submittal is provided with the request for final O&M manuals. The filename is posted near the top of the review form. Filenames use the “eight dot three” convention (XXXXX_YY.PDF) where XXXXX is the specification section number and YY is an ID number. If technical problems require you to break the submittal into more than one file then add a letter extension to the end of each filename. (example: 19876_01A.PDF) Keep the number of files to a minimum.

3) Scan images at a resolution of 400 dpi or greater. Perform Optical Character Recognition (OCR) capture on all images. Achieve OCR with the “original image with hidden text” option (as seen in Adobe Acrobat Exchange 4.05).

4) Create one PDF document (PDF file) for each equipment O&M Manual. The entire manual is converted to a single PDF file via scanning or other method of conversion. Drawing or other graphics must be converted to PDF format and made part of the one PDF document. Rotate pages that must be viewed in landscape to the appropriate position for easy reading. Word searches of the PDF document must operate successfully. (proof of OCR)

5) Create a bookmark in the navigation frame, for each entry in the Table of contents. Three levels deep is usually enough (i.e. Chapter, Section, Sub-section)

6) Generate thumbnails for each completed PDF file.

7) Set the opening view for PDF files as follows:

a) Initial view: Bookmarks and page

b) Magnification: Fit in window

c) Open to the cover page of the manual, with bookmarks to the left, and the first bookmark linked to the table of contents.

b. All component equipment manuals shall be provided in .PDF format.

c. All Project drawings shall be provided in AutoCAD 2000 and .PDF format.

9. Equipment Identification

a. Identify products and components by their Tag and descriptive names. The use of cryptic model or catalog numbers or letters for identification shall not be acceptable.

b. Indicate all components of the equipment on catalog pages by bold markings or some other clearly definable medium for ease of identification. All markings shall be readable if photocopied.

B. Letter of Transmittal:

a. The Seller shall provide a Letter of Transmittal with each submittal and include the following in the letter:

b. Date of submittal.

c. Contract title and number.

d. Seller's name and address.

e. A list of the attachments and the Sections of the Manual to which they relate.

f. Reference to or explanation of related submittals already made or to be made at a future date.

C. The Seller shall prepare INSTALLATION Manuals for the Installation of the Goods by the Contractor.

1. The Seller shall submit six copies marked "INSTALLATION" of each required O&M manual to the Contractor. Each manual shall include an electronic version containing the information contained in the manual. Distribution by Contractor shall be as follows:

a. The Contactor shall retain 3 copies

b. The Engineer shall receive 2 copies

c. The Buyer shall receive 1 copy

2. The Seller shall organize the "INSTALLATION" manuals as follows

a. Seller Equipment Installation Manual

1) Seller Equipment Installation Instructions

2) Contractor Training Information

3) Painting Touch up and Repair Instructions

4) Equipment Cross-Reference Schedules

a) For all tagged devices supplied, the Seller shall develop an "Cross Reference Schedule" that matches the Tag to the appropriate equipment manual. The equipment schedule shall include the pertinent information associated with the equipment including tag number, description, functional name location, component equipment model, part number, size, materials, accessories and range. The equipment cross-reference schedule shall be provided in the form of a Microsoft Excel (.XLS) spreadsheet.

b. Component Equipment O&M Manuals

1) Includes all Division 46, including Section 46 61 34 - Containerized Membrane Filtration System, (excluding membrane equipment) and Division 43 approved or “as constructed by Seller” shop drawing submittals and equipment Installation, Operational and Maintenance Manuals.

c. Instrumentation and Control Equipment Manuals

1) Includes all Division 40 approved or “as constructed by Seller” Shop Drawing Submittals and Equipment Installation Operational and Maintenance Manuals.

d. Electrical Equipment Manuals

1) Includes all Division 26 approved or “as constructed by Seller” Shop Drawing Submittals and Equipment Installation, Operational and Maintenance Manuals.

e. All “As Constructed” Project Drawings

D. PRELIMINARY O&M Manual:

1. The Seller shall submit six copies marked “PRELIMINARY” of each required O&M manual and the training plan. Each manual shall include an electronic version containing the information contained in the manual.

2. The Seller shall organize the PRELIMINARY O&M Manuals as follows:

a. Seller Equipment O&M Manual

1) Includes O&M and Preventive Maintenance Instructions

2) Includes Detailed Plan of Commissioning Activities

3) Includes the Equipment Cross-Reference Schedule

b. Component O&M Manuals

1) Includes all Division 5, Section 46 61 34, Containerized Membrane Filtration System, (excluding membrane equipment) and Division 15 approved or “as constructed by Seller” equipment Installation, Operational and Maintenance Manuals.

c. Instrumentation and Control O&M Manuals

d. Electrical Equipment Manuals

e. Equipment Specific and Factory Test Reports Manual

f. Seller and Component Equipment Suppliers Training Manual(s)

g. All “As Constructed” Project Drawings

E. After the Acceptance Testing has been completed the Seller shall revise and resubmit the FINAL O&M Manuals for the project. Eight final copies of each of the required Operation and Maintenance Manuals shall be submitted. Each manual shall contain an electronic version containing the information contained in the manual.

1. FINAL O&M Manual(s):

2. The Seller shall submit six copies marked “FINAL” of each required O&M Manual. Each manual shall include an electronic version containing the information contained in the manual.

a. The Seller shall organize the FINAL O&M Manuals as follows:

1) Seller Equipment O&M Manual

2) This O&M Manual will be provided “as new in its entirety.”

3) Includes O&M and Preventive Maintenance Instructions

4) Includes an equipment cross-reference schedule

5) Includes a FINAL electronic version

b. Component O&M Manuals

1) This Manual will include only changes from the PRELIMINARY to FINAL Versions. The Seller shall provide new Manual Covers or Binders

2) Includes a FINAL electronic version

c. Instrumentation and Control O&M Manuals

1) The Seller PLC/HMI Manuals will be provided “as new in its entirety.”

2) The component equipment manuals include only changes from the PRELIMINARY to FINAL Versions. The Seller shall provide new Manual Covers or Binders

3) Includes a FINAL electronic version.

d. Electrical Equipment Manuals

1) The Electrical Equipment Manuals include only changes from the PRELIMINARY to FINAL Versions. The Seller shall provide new Manual Covers or Binders

2) Includes all Electrical, Shop Drawing Submittals and Component Equipment O&M Manuals

3) Includes a FINAL electronic version

e. Equipment Specific and Factory Test Reports Manual

1) The FINAL Factory Test Report Manual shall include only changes from the PRELIMINARY to FINAL Versions for Component Equipment. The Seller shall provide new Manual Covers or Binders.

f. Commissioning Test Reports Manual shall include:

1) Results of all installation inspection, field calibration, and field testing reports prepared during the commissioning of the facility

2) Results of membrane module installation and integrity testing

3) Results of Acceptance Testing

g. All “as installed” project drawings will be provided “as new in its entirety” and include a FINAL electronic version.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

FSECTION 01 73 10 - TRAINING OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work

1. This Section describes training of membrane systems. Balance of equipment training is described in Section 01 79 00 – Owner Staff Training.

2. The Seller shall provide formal training of the Buyers' personnel. Training shall commence after the "Notice of Completed Commissioning" is issued.

   a. Training of the Buyer's personnel shall commence within a period of 14 days after the "Notice of Completed Commissioning" has been issued as mutually agreed to by the Buyer, Engineer, Contractor and Seller.

   b. Training shall be conducted for first shift during normal working hours.

   c. Training shall be completed within the time allocated in the Agreement.

   d. The Engineer shall document the time when the facilities are substantially unavailable for use by the Seller to perform training due to circumstances beyond the control of the Seller including but not limited to power outages, lack of feedwater, inability to transfer product water or feedwater due to factors beyond the control of the Seller, not having adequate staff from the Contractor or the Buyer. If in the sole opinion of the Engineer the facilities are substantially unavailable to the Seller, equivalent additional time for training will be granted.

   e. Failure of the Seller to complete the Training as required by this Section within the allocated time, shall constitute a failure of the Seller to provide Special Services in accordance with the requirements of the Contract. The Seller shall be assessed Liquidated Damages in accordance with Article 5 of the Agreement until Training is complete.

   f. Upon successful completion of the Training required by this Section, the Engineer will issue a "Notice of Completed Training".

   g. The Seller shall maintain record of the individuals that have completed training and provide information required for the documentation of Professional Development Hours required for the Buyer's personnel.

3. The Seller shall provide the services of factory-trained specialists to train the Buyer's personnel in the recommended operation and the preventive maintenance procedures for all equipment provided by the Contract Documents.

4. The Seller shall provide a combination of classroom and hands-on training. All training shall be conducted at the Buyer's location.

5. The following Levels of Training Shall Be Provided.

Level of Training	Number of Shifts	Maximum Number of Participants	Classroom Training (Hours)	Hands-On Training (Hours)
Membrane System	1	8	8	16
Mechanical Equipment	1	8	8	16
Instrumentation and Control Equipment	1	4	8	16
PLC / HMI	1	4	16	16

6. Hands-On Training shall be limited to groups of 8. In the event that more than 8 personnel are to be trained, multiple hands-on training sessions shall be conducted.

7. The Seller shall be responsible for all costs associated with training and shall provide required materials, texts, and supplies.

8. Training shall be conducted in normal eight (8) hour working days until conclusion of the training course.

9. Training sessions may be video recorded by the Buyer at the Buyer's expense.

10. Training material shall be provided to the Buyer in written and electronic format.

11. Training shall be performed by the Seller and component equipment suppliers. The Seller shall be responsible for the training on the design and operation of the equipment and systems provided. This includes:

    a. Membrane System

        1) Membrane Filtration Theory

        2) Membrane Filtration System

        3) Membrane Filtration Units

        4) Membrane Filtration Processes

            a) Start Up, Shut Down

            b) Filtration, Backwashing

            c) Maintenance Cleaning, Chemical Washing, Backwash and Clean in Place

d) Integrity Testing and Module Repair

5) Routine and Non-Routine Maintenance

b. Component Equipment Training

1) Equipment, Equipment (including pumps, compressors)

2) Mechanical, Equipment (valves, actuators, and positioners)

c. Instrumentation and Control Component Equipment Training

1) Switches

2) Meters and Transmitters

3) Analyzers

d. Instrumentation and Control Process Logic Control/HMI Training

1) Process Logic Control Equipment

2) HMI System Training

12. Component Equipment Suppliers: The Seller shall retain the services of manufacturer's representative(s) for training of the following equipment provided by the Seller.

a. Pumps

b. Compressors

c. Process Logic Control Equipment

d. HMI System Programming

e. Other equipment provided by the Seller where the Seller is not qualified to provide authorized factory level training

B. Reference Specifications

1. Section 01 66 00 - Commissioning of Membrane Equipment

2. Section 01 67 00 - Acceptance Testing of Membrane Equipment

3. Section 01 73 00, Installation, Operation and Maintenance Manuals

4. Section 46 61 34 - Containerized Membrane Filtration System

C. Coordination:

1. The Seller shall coordinate these services at times acceptable to the Buyer, with a minimum of 5 days prior notice.

1.02 QUALITY CONTROL / QUALITY ASSURANCE (QA/QC)

1. The qualifications of specialists shall meet the requirements of this Section and are subject to approval by the Engineer.

1.03 SUBMITTALS

A. Training Manuals shall be provided with the PRELIMINARY O&M Manuals. Refer to Section 01 73 00 - Installation, Operation and Maintenance Manuals.

B. The Seller shall develop and submit to the Engineer and Buyer a Training Manual. The Training Manual Plan shall include the elements presented in this Section or as required by the Seller or component equipment supplier.

C. The Seller shall prepare a Training Lesson Plan, provide qualified instructors, and schedule the training in an organized manner.

1. Proposed lesson plans for scheduled instruction shall be submitted 15 days prior to the commencement of training. Lesson plans shall be approved by the Engineer a minimum of 5 days prior to scheduled instruction. All training material shall be provided to the Buyer in electronic format.

2. Credentials for the Seller’s designated instructor(s) shall be submitted thirty (30) days prior to the commencement of training. Credentials shall include a brief resume and specific details of the instructor(s) pertaining both to personal experience operating and maintaining the specified equipment and conducting operation and maintenance for the same equipment.

3. The Seller’s proposed lesson plans shall detail specific instruction topics. Training aids to be utilized in the instruction shall be referenced and attached where applicable to the proposed lesson plan. "Hands-on" demonstrations planned for the instruction shall be described in the lesson plan.

4. The Seller shall indicate the estimated duration of each segment of the training in the lesson plan.

5. Submit information as required by the local primacy agency in support of Professional Development Hours.

1.04 PRODUCT DELIVERY STORAGE AND HANDLING (NOT USED)

1.05 SPECIAL PROJECT CONSIDERATIONS

A. Training Aids

1. The Seller’s instructor shall incorporate training aids as appropriate to assist in the instruction. As a minimum, the training aids shall include text and figure handouts. Texts shall be bound within three-ring binders. Other appropriate training aids are:

a. Audio-visual aids (e.g., films, slides, videotapes, overhead transparencies, posters, blueprints, diagrams, catalogue sheets)

b. Equipment cutaways and samples (e.g., spare parts and damaged equipment)

c. Tools (e.g., repair tools, customized tools, measuring and calibrating instruments)

2. The Seller's instructor shall utilize descriptive class handouts during the instruction. Photocopied class handouts shall be good quality reproductions. Class handouts should accompany the instruction with frequent reference made to them. Customized handouts developed especially for the instruction are required. Handouts planned for the instruction shall be attached with the manufacturer's proposed lesson plan.

B. "Hands-On Demonstration"

1. The Seller's instructor shall present "hands-on" demonstrations of operations and maintenance of the Seller supplied and component equipment. The proposed "hands-on" demonstrations should be described in the Seller's proposed lesson plan.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 OPERATOR TRAINING

A. Training: The instruction lesson plan shall include the following as a minimum:

1. Equipment Operation:

a. Describe equipment's operating (process) function

b. Describe equipment's fundamental operating principals and dynamics

c. Identify equipment's mechanical, electrical, and electronic components and features

d. Identify all support equipment associated with the operation of subject equipment (e.g., compressed air intake filters, valve actuators, motors)

e. Recommend standard operating procedures to address start-up, routine monitoring, and shut-down of the equipment

2. Detailed Component Description:

a. Identify and describe in detail each component's function

b. Group related components into subsystems, where applicable. Describe subsystem functions and their interaction with other subsystems

c. Identify and describe in detail equipment safeties and control interlocks

3. Equipment Preventive Maintenance (PM):

a. Describe PM inspection procedures required to:

1) Perform an inspection of the equipment in operation

2) Spot potential trouble symptoms and anticipate breakdowns

3) Forecast maintenance requirements (predictive maintenance)

b. Define the recommended PM intervals for each component

c. Provide lubricant and replacement part recommendations and limitations

d. Describe appropriate cleaning practices and recommend intervals

e. Identify and describe the use of special tools required for maintenance of the equipment

f. Describe component removal/installation and disassembly/assembly procedures

g. Perform "hands-on" demonstrations of preventive maintenance procedures

h. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate

i. Define recommended torquing, mounting, calibration, and/or alignment procedures and settings, as appropriate

j. Describe recommended procedures to check/test equipment following a corrective repair.

4. Equipment Troubleshooting

a. Define recommended systematic troubleshooting procedures

b. Provide component specific troubleshooting checklists

c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting

END OF SECTION

SECTION 01 74 00 MEMBRANE SYSTEM AND MODULE WARRANTY

PART 1 -- GENERAL

1.01 SUMMARY

A. Section includes:

1. Membrane system and module warranty information.

2. This section covers the membrane system equipment and module warranty. This section addresses the requirements in conjunction with the provisions of Paragraphs 9.01, 9.03, and 9.04 of the General Conditions.

B. Related specification sections include but are not necessarily limited to:

1. Division 00 - Procurement and Contracting Requirements.

2. Division 01 - General Requirements.

3. Section 46 61 34 - Containerized Membrane Filtration System

1.02 QUALITY ASSURANCE

A. Referenced standards:

1. ASTM International:

a. D6908, Standard Practice for Integrity Testing of Water Filtration Membrane Systems.

B. Seller's Quality Assurance/Quality Control (QA/QC) Procedures

1. Submit for approval, prior to the shipment of the membrane modules, reports in letter format for each membrane module. At a minimum, the reports shall include:

a. The membrane module model and part number, manufacturing lot number and serial number. Indicate the nominal and absolute pore size, inside and outside fiber diameter, effective fiber length, and effective feed side surface area of the membrane module.

b. The membrane module normalized specific flux (permeability, gfd/psi at 20°C).

c. A certification by the membrane module supplier that:

1) Each membrane module has passed the Seller's QA/QC (integrity) tests.

d. Certification of wet testing for each membrane module conducted at the Seller's facilities. Seller shall certify that each membrane module has passed the QA/QC tests for membrane element integrity. Acceptable QA/QC tests include bubble point or pressure hold tests above the minimum value recommended by the Seller and approved by the Engineer.

e. Identify modules that have undergone pinning or repair for more than 0.1 percent of original fibers at the factory.

2. Certificates of Warranty

a. Submit a listing of chemical constituents, concentrations and exposure times that would void the membrane warranty.

1.03 DEFINITIONS

A. Log Reduction Value (LRV): The filtration removal efficiency expressed as $\log_{10}$ for a target organism or surrogate.

B. Membrane Module(s): Hollow fiber membranes arranged as a module that is a sub-assembly of a MF/UF Unit.

C. Membrane Integrity Failure Occurrence:

1. A loss of integrity (e.g., partial or complete fiber breaks) that results in less than 4-log (LRV of 4 or 99.99 percent filtration efficiency for a removal of 3 micron or larger particles) as determined by an air pressure based Direct Integrity Test such as the:

a. Pressure Decay Test.

b. Diffusive Airflow Test.

c. Correlated Airflow Measurement Test:

1) A pressure decay test, applying Hagen-Poisseville equation per ASTM D6908.

d. Other conforming integrity tests that satisfy the criteria for test resolution and sensitivity as described by any recognized independent method developed by a consortium of membrane module manufacturers or described and accepted as a method by the primacy agency.

2. MF/UF System: The complete MF/UF System is comprised of multiple MF/UF Units and all ancillary equipment.

D. MF/UF Unit(s): One (1) complete filtration unit including valves, pumps, controls, and piping capable of producing filtered water.

E. Substantial Completion: See Division 0 - General Conditions.

1.04 SUBMITTALS

A. Shop Drawings

1. Membrane Warranty

    a. Submit design calculations to substantiate the 4-Log Membrane LRVs for air pressure integrity testing. Perform calculations based upon a broken fiber·lumen(s) or a microporous defect of 3 microns to determine the worst-case membrane integrity defect scenario.

    b. Provide a listing of chemical constituents, concentrations and exposure times that would result in voiding the membrane warranty.

    c. For each of the above chemical constituents, identify the instrumentation required and alarm limits necessary to satisfy the warranty provisions of this section.

2. MF Membrane Modules:

    a. Include module construction details.

        1) Materials of construction.

        2) Dimensions.

        3) Standard commercial part numbers and materials for elastomeric seals. Note that Buna-N seals are not acceptable.

    b. Include standard performance parameters.

        1) Operating temperature.

        2) pH and oxidant tolerance (continuous and intermittent).

        3) Range of membrane flux.

        4) Clean water normalized specific flux (permeability or resistivity).

        5) Minimum bubble point or maximum pressure decay test parameters.

    c. Include storage and handling requirements.

    d. Provide standard operating and maintenance data including storage solutions (concentration and volume) used during shipment and recommended rinsing solutions (concentration and volume) and long-term/short-term storage protocols.

B. Factory Test Reports

1. Prior to delivery of the membrane modules, submit the following:

    a. Seller shall identify each membrane module by a unique serial number and indicate the membrane lot.

b. Seller shall provide the membrane specification sheets that specify each membrane module's normalized specific flux (gfd/psi at 20°C), nominal pore size, and the nominal inside and outside surface area of the filter module.

c. Certification of wet testing for each membrane module conducted at the Seller's facilities. Seller shall certify that each membrane module has passed the QA/QC tests for membrane element integrity. Acceptable QA/QC tests include bubble point or pressure hold tests above the minimum value recommended by the membrane module supplier and as approved by the Engineer.

C. Certificates of Warranty

1. The listing of chemical constituents, concentrations, and exposure time that would void the membrane warranty.

1.05 MEMBRANE SYSTEM WARRANTY

A. During the Correction Period, the Seller shall furnish an equipment warranty certificate assuring the containerized membrane filtration units and system (including membrane modules) will meet the service conditions specified in Section 46 61 34 - Containerized Membrane Filtration System, Paragraph 2.01.

B. Seller warrants satisfactory performance of the Goods to achieve equipment performance (e.g., design flows, water recovery, backwash, chemical washing, and Clean-In-Place (CIP) intervals) and water quality (e.g., integrity failure) objectives and complies with the concept of linear scalability as defined in the Agreement.

C. In the event that the Buyer does not believe that the Goods meet the specifications, including the criteria of linear scalability, the Buyer shall notify the Seller that the conditions for a breach of contract exist. Seller shall provide at no cost to the Buyer pilot equipment of the type and kind evaluated during the pilot testing, if not available to the Buyer, to verify the compliance with the specifications. In the event that the Buyer determines that the equipment does not comply with the specifications including the concept of linear scalability, the Seller shall provide an acceptable remedy to the Buyer in accordance with the General Conditions. If an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

D. If the Goods are non-conforming and unable to conform to the equipment performance objectives for criteria other than linear scalability, the Buyer will notify the Seller in accordance with the procedures identified in Paragraph 9.03 of the General Conditions. Buyer shall make available to the Seller electronic records for Seller review. Seller shall be given 10 days to develop a plan to remedy the non-conformance.

E. If within 60 days after the notification to the Seller it has become apparent to the Buyer that the remedy is not acceptable, the Buyer will provide notice to the Seller that the conditions for breach of contract exist. If within 30 days an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

F. Buyer recognizes that to remedy system warranty provisions, the Seller may need to modify operational protocols. Seller recognizes that any change to the operational protocols must be acceptable to the Buyer. Buyer recognizes that any changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

1. That the specified design parameters (e.g., production capacity, water quality, system recovery, and chemical cleaning interval) are obtained.

2. That the change in operational parameters and protocols (e.g., backwash, chemical washing, or chemical cleaning) will not represent an increase in operational or membrane replacement costs to the Buyer.

1.06 MEMBRANE MODULE WARRANTY

A. General:

1. Seller warrants that the membrane modules will be used for the treatment of water for drinking purposes and that in accordance with Paragraph 5.08 of the General Conditions the membrane modules are fit for the intended purpose.

2. Membrane modules and elements purchased by the Buyer or otherwise provided under the Agreement or as a future membrane replacement shall be provided with the same warranty as the membrane modules and elements provided as part of the original equipment installation.

3. Seller warrants that the membrane modules and elements will be free from non-conformance in:

a. Materials.

b. Workmanship.

c. Membrane integrity failure.

d. Irreversible flux loss.

B. Membrane Module and Element Warranty Periods

1. Seller shall warrant the performance of the supplied MF/UF membrane modules for a period of not less than ten (10) years (inclusive of the five (5) years full replacement warranty period) from the date of Substantial Completion.

a. The warranty shall guarantee the performance of the membrane modules so as to meet the MF/UF system design and performance criteria specified in Section 46 61 34, Containerized Membrane Filtration System.

b. Membrane modules that within the first year become non-conforming, as defined by the requirements specified herein, must be replaced with new membrane modules at no cost to the Buyer.

2. Seller’s membrane module and element warranty periods have been established in the Proposal.

a. Seller's membrane module warranty period shall commence the day water first touches membrane modules or 6 months after shipment (whichever comes first) and continue until the end of the pro-rata warranty period submitted by the Seller with the Bid.

b. The membrane module and element warranty periods shall consist of two (2) parts: a full replacement warranty period and a pro-rata warranty period.

1) The full replacement warranty period shall last for a period of at least five (5) years after the day water first touches membrane modules or 18 months after delivery (whichever comes first) as described below:

a) For membrane modules or elements supplied as part of the original equipment installation, the day water first touches membrane modules or 18 months after delivery (whichever comes first) is when the full replacement warranty period commences.

b) For membrane modules or elements provided after the day water first touches membrane modules or 18 months after delivery (whichever comes first), the full replacement warranty period begins the date the membrane module or element is placed into service.

c) Buyer shall record and maintain records of the date of installation for all membrane modules and elements.

2) The pro-rata warranty period of five (5) years shall commence with the end of the full replacement warranty period and last until the end of the pro-rata warranty period as submitted by the Seller in the Bid.

C. In the event that the Goods do not meet the performance requirements specified, including the criteria of linear scalability, the Buyer shall notify the Seller in writing requesting warranty replacement modules.

1. Following return notification, the Seller shall have an optional 10-day period to provide on-site troubleshooting and/or repair of the defective Goods.

D. In the event that the capacity or quality cannot be regained through these efforts, an adequate number of modules will be replaced as per the terms of the warranty to recover system performance within the parameters specified in Section 46 61 34, Containerized Membrane Filtration System.

E. If within 60 days after the notification to the Seller it has become apparent to the Buyer that the remedy is not acceptable, the Buyer will provide notice to the Seller that the conditions for breach of contract exist.

1. If within 30 days following such notice an acceptable remedy is not obtained, the Buyer shall notify the Seller that a breach of contract exists.

F. Buyer recognizes that to remedy system warranty provisions, the Seller may need to modify operational protocols.

1. Seller recognizes that any changes to the operational protocols must be acceptable to the Buyer.

2. Buyer recognizes that any changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

    a. That the specified design parameters (e.g., production capacity, water quality and system recovery) are obtained.

    b. That the change in operational parameters and protocols (e.g., backwash, chemical cleaning, or recovery cleaning) will not represent an increase in operational or membrane replacement costs to the Buyer.

    c. Revised protocol is subject to review and approval by the Buyer and/or Engineer.

G. Limitation of Membrane Module and Element Warranty

1. Buyer recognizes that the occurrence of any of the following shall void the membrane module and element warranties:

    a. Physical damage or faulty installation of the membrane modules or elements by anyone other than Contractor, Seller, or Seller's authorized representative.

    b. Unauthorized alteration of components manufactured by the Seller.

    c. Catastrophic exposure to chemicals or deleterious substances not normally associated with water treatment as a result of accidents, vandalism or other acts that are outside the bounds of routine and normal water treatment plant operations.

    d. Use of water treatment chemicals, chemical cleaning solutions or cleaning procedures other than chemicals, solutions and procedures approved by the Seller.

    e. Exposure of the membrane modules or elements to treated water or water treatment chemicals at concentrations above levels or contact times acceptable to the Seller.

        1) Seller is responsible for providing the Buyer a listing of the known water treatment and cleaning chemicals and concentrations and times of exposure that could result in membrane damage.

        2) Operation or cleaning of any membrane module or element outside the stated chemical limits shall void the remaining portion of the membrane module or element warranty.

    f. Improper maintenance of equipment, as defined in the Technical/O&M Manual.

    g. Failure of the Buyer to maintain operational logs as required by the Seller.

        1) The maintenance of electronic logs is subject to the following conditions:

            a) Seller is responsible for providing the Buyer a listing of the operational data points that are to be electronically logged.

b) Seller is responsible for the control programming of data points that are to be electronically logged.

c) Seller shall identify minimum frequencies of logging of all operational data points required by the Seller to maintain membrane module and element warranty provisions.

d) Seller shall establish the alarm and shutdown limits that would result in the operation of the equipment outside of Seller acceptable limits.

e) Seller shall be solely responsible for the identification and programming of system interlocks that would result in the operation of the system outside of the parameters required by the Seller.

(a) Buyer will not be responsible for errors in Seller developed programming that would result in improper operation of the system.

h. In the event of a warranty claim, failure of the Buyer to provide the Seller with operational logs.

2. Buyer will assume responsibility of maintaining a hand-written log if an occurrence develops that is totally outside the bounds of routine and normal operation or automated operation.

a. Such items would include obtaining water analyses, or catastrophic events (e.g., discharges of foreign objects or chemicals that are outside the normal operation of a water treatment facility).

3. Changes in the Seller established operational and maintenance guidelines cannot be applied retroactively to invalidate the membrane module or element warranties.

4. Seller is solely responsible for the identification of water quality parameters normally associated with water treatment and water treatment chemicals and cleaning solutions (for procedures approved by the Seller), and for identification of instrumentation and control programming required to satisfy and maintain membrane module and element warranty provisions for operation and cleaning.

5. Buyer recognizes that to satisfy warranty requirements, the Seller may provide membrane replacement modules or elements that embody changes in module or element design and construction features.

a. Buyer recognizes that the replacement of membrane modules or elements pursuant to this warranty with a different membrane module or element is acceptable under the following conditions:

1) That the specified design and operational parameters (e.g., design flows, water quality, system recovery and chemical cleaning intervals) are obtained.

2) That the change in membrane modules or elements will not represent an increase in the operational or membrane module or element replacement costs to the Buyer.

3) The revised module or element must also be in compliance with regulatory requirements.

H. Membrane Module and Element Pricing

1. Seller shall establish the membrane module and element prices (as indicated in the Proposal Pricing Form) and guarantees that:

a. Membrane modules and elements have been provided to the Buyer at prices not exceeding the prevailing market price.

b. In the Proposal Pricing Form, the Seller shall indicate the cost escalated Consumer Price Index (CPI) used to calculate the replacement price.

1) The CPI adjustment is the most recent Month CPI Index divided by the CPI Index for the month of the Bid submittal.

c. The CPI Index to be used shall be the "CPI-U, US City Average, all Items (non-seasonally adjusted)" as compiled by the U.S. Department of Labor.

2. During the full replacement warranty period, the Seller shall provide replacement modules and elements for non-conforming modules and elements at no cost to the Buyer.

3. Module and element prices during the pro-rata warranty period shall be calculated as follows:

~~a.~~ Pro Rata Module Price = (Module Price x applicable CPI adjustment x Months of Beneficial Use)/Membrane Module Pro-Rata Warranty Period (Months).

I. Membrane Module Integrity:

1. Membrane Integrity Test Frequency:

a. Membrane Integrity testing shall be performed daily.

2. LRV Determination

a. The operating Log Reduction Value (LRV) shall be determined at the maximum design flux and maximum Transmembrane Pressure (TMP), if calculated using the test result on an intermittent basis.

b. The LRV shall be determined at the operating flux and TMP, if calculated using the test result on a continuous basis using the result of the last direct integrity test.

c. The LRV calculation shall include the applicable adjustment for the "concentration factor" as described in the Direct Integrity Test provisions of the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

d. If empirical data is used for the calculation of LRV, the Seller will provide adequate evidence (e.g., results of challenge testing at the Seller membrane integrity test pressure, air and water flow/pressure drop data) to support the correlation between air pressure integrity test result and LRV based upon a “flow limiting orifice” criteria for a broken lumen at the membrane - membrane pot interface for approval by the Engineer.

3. Membrane Integrity Failure

a. Membrane modules shall be considered to have non-conforming integrity failure if the number of Membrane Integrity Failure Occurrences per membrane unit exceeds three (3) occurrences in a three (3) month period or six (6) occurrences in a 12 month period. A failing membrane integrity test shall be considered a Membrane Integrity Failure Occurrence if the problem is resolved by pinning of a membrane fiber.

1) Seller will define the number of fiber breaks per Unit that constitutes Membrane Integrity Failure Occurrence for their particular membrane module.

b. If a Membrane Integrity Failure Occurrence is identified:

1) Module(s) may be isolated from service and the system retested. If isolation of the modules(s) restores Unit integrity requirements, the Unit may be placed back into service.

2) The individual modules shall be pin repaired, or replaced if pin repair is not possible, and the Unit will be retested and returned to service. The membrane module serial number and number of membrane fibers repaired shall be recorded. The Membrane Integrity Failure Occurrence shall be documented by the Buyer.

3) For subsequent Membrane Integrity Failure Occurrences, module(s) may be isolated from service and the Unit placed back into service unless the cumulative area isolated from the Unit reduces the MF/UF System Firm Capacity below that which is required.

4) If module(s) cannot be isolated from service, then all defects in that Unit shall be repaired or replaced (if repair is not possible), and the Unit retested and placed back into service.

5) The membrane module serial number and number of membrane fibers repaired shall be recorded.

c. Individual membrane module(s) shall be considered to have integrity failure under the following conditions:

1) Prior to Acceptance Testing

a) If more than 0.25 percent of the fibers are pinned prior to commencement of the Acceptance Testing.

2) After Acceptance Testing

a) If for a single membrane module, more than 0.05 percent of the fibers have required repair (e.g., by pinning or gluing) in any 12 consecutive months.

3) Anytime

a) An individual membrane fiber shall be defined as requiring repair if it visually leaks during an air pressure integrity test at the integrity test pressure.

b) If a module assembly fails the air pressure integrity test and cannot be repaired by pinning or gluing, then the module is considered defective.

c) If the cumulative repairs from the date of manufacture raise the flux rate 0.1 percent above the design flux rate.

d) If more than 0.5 percent of the fibers have required repairs over the life of the membrane module. An individual membrane fiber shall be defined as requiring repair if it visually leaks during an air pressure integrity test at the integrity test pressure.

d. If a membrane unit exceeds the maximum amount of Membrane Integrity Failure Occurrences, all membrane modules within the membrane unit shall be replaced unless:

1) Seller can demonstrate, through lot traceability, that the Membrane Integrity Failure Occurrence is attributed to a specific lot of membrane modules within a previously defined range of consecutive serial numbers.

2) The lot size shall be established by the membrane module manufacturer but shall not be less than 25 modules.

3) The number of membrane modules that are accountable for the Membrane Integrity Failure Occurrences are “localized” to less than 10 percent of the membrane modules located on the membrane unit.

e. If it is demonstrated that the membrane integrity failure defect is attributed to a specific lot or localized, then all membrane modules that have had more than a single previous occurrence of repair shall be replaced, even though they may be located in another membrane unit or may not have exceeded the criteria for individual membrane module integrity failure.

f. If more than two (2) membrane units require complete replacement within a 12 month period, the Buyer shall retain the option to replace all remaining membrane modules.

g. After Final Acceptance, if a membrane module is determined to be non-conforming with respect to membrane integrity, the Seller will remedy in accordance with the requirements set forth in this section.

1) Non-conforming membrane modules may be returned to service under the conditions outlined in this section.

2) If within 60 days after the notification to the Seller it has become apparent to the Buyer that membrane modules are not able to meet the provisions of the warranty, the Buyer will provide the Seller with a breach of warranty claim.

J. Irreversible Flux Loss

1. Membrane modules or elements shall be considered to have non-conforming irreversible flux loss under the following condition.

Definition of “clean water” resistance: The temperature corrected membrane resistance is defined as the “clean water” membrane resistance, as indicated in the Proposal Pricing Form, taken at a minimum of one (1) hour after startup of the membrane unit after completion of the chemical cleaning process, and taken five (5) minutes after completion of the most recent backwash. The temperature correction shall be calculated at 20°C using a viscosity correction factor. The equations and units used to calculate “clean water: resistance are as follows:

$$R = \frac{\Delta P}{J\mu}$$

Where: R = Membrane Resistance (psid/gfdcp)
J = Membrane Flux (gfd)
μ = Viscosity of water (cp)
ΔP = Differential Pressure (psid)

a. Irreversible Flux loss will be stated to have occurred if the MF/UF Units are not able to obtain a minimum of a 30-day clean-in-place (CIP) intervals respectively for 3 consecutive CIP intervals when operated at or below the temperature adjusted membrane design capacity using backwash (MF/UF Units only) and chemical washing procedures and frequencies established and demonstrated for the particular system during the Performance Testing Period.

b. Prior to the end of the first year or operation, each unit will be tested for permeability.

1) Prior to the permeability test, a CIP will be performed.

a) Seller will be allowed to observe the automated CIP cycle.

b) Bid temperature corrected flux rate will be set for each cell prior to the permeability test.

c) The permeability test duration will be run for a minimum of 5 minutes.

2) If the permeability is not at least 95 percent of the baseline permeability established following a CIP performed after at least 30 days of initial operation at the design capacity, the modules will be considered to have non-conforming irreversible flux loss.

a) Note: H2OI determined a baseline permeability of 7 gfd/psi at 20 degC. Prior to the end of the first year of operation, each UF train will be tested to confirm post-CIP permeability restoration to at least this baseline. It is important to note that terminal permeability (the value at which the UF system is no longer able to make the rated design flow) is 1.5 gfd/psi which is derived from maximum instantaneous design flux divided by the maximum TMP. The baseline permeability of 7 gfd/psi is a very conservative value more than 4.5 times greater than the terminal permeability value.

2. In the event that the Seller does not believe that the feed water quality is similar to that defined as the design water quality in Section 46 61 34, Containerized Membrane Filtration System, then the Seller may seek relief from its warranty obligations hereunder to the extent that its failure to meet these obligations is caused by a change in the influent water quality that is outside the range of the design influent water quality parameters.

    a. However, relief shall require demonstration that there is a defensible water quality parameter and/or duration that is outside of the influent water quality range that caused the warranty violation.

3. Should the Buyer and the Seller fail to agree on the cause of the warranty violation that is related to influent water quality, the matter shall be sent to binding arbitration.

    a. The Buyer and the Seller shall jointly select an arbitration panel consisting of water treatment professionals appointed by each party.

    b. The panel will consist of two members of each party or other mutually agreed upon number.

    c. The panel will then select 1 additional member as mutually agreed upon.

4. The Buyer recognizes that to remedy warranty provisions for irreversible flux loss, the Seller may modify operational protocols.

    a. Seller recognizes that changes to the operational protocols must be acceptable to the Buyer.

    b. The Buyer recognizes that the changes to operational protocols by the Seller pursuant to this warranty provision are acceptable under the following conditions:

        1) That the specified design parameters (e.g., production capacity, water quality, system recovery and CIP interval) are obtained.

        2) That the change in operational parameters and protocols (e.g., backwash, Maintenance Clean or CIP) will not represent an increase in the operational or membrane replacement cost to the Buyer.

c. If more than two units require membrane replacement at any time within Membrane Module Warranty Period for irreversible flux loss, the Buyer shall retain the option to replace all remaining membrane modules using the applicable membrane module price.

PART 2 -- PRODUCTS – (NOT USED)

PART 3 -- EXECUTION – (NOT USED)

PART 4 -- SUPPLEMENTAL INFORMATION

4.01 MEMBRANE LIMITS

Normal Operation

Transmembrane Pressure	-3 bar to + 3 bar (-43.5 psi to + 43.5 psi)
pH	1 to 10
Temperature	0 to 40 degrees C. Consult Pall before using any water treatment polymers

Membrane Cleaning (Includes CIP/MC Processes)

The following values are listed as maximum values that would potentially void the module warranty. Typical CIP and EFM values should be provided by Seller.

Temperature	40 degrees C. maximum
Sodium Hypochlorite	5,000 mg/L maximum
NaOH	20 g/L maximum
Citric Acid	100 g/L maximum

Membrane Storage

Store modules between 1 and 40 degrees C. Do Not Freeze.

Short Term Storage: If not in use, flush daily with up to 100 mg/L of free available chlorine.

Long Term Storage: First perform a Clean in Place, store wet, completely filled with 50-mg/L sodium hypochlorite solution. according to seller requirements.

END OF SECTION

SECTION 01 74 10 - TESTING AND DISINFECTION OF CONCRETE AND STEEL WATER STRUCTURES

PART 1 - GENERAL

1.1 THE SUMMARY

A. The Contractor shall test and disinfect concrete and steel hydraulic structures in accordance with the Contract Documents.

B. The Contractor shall be responsible for obtaining permits for discharging excess testing and disinfection water and dechlorination of such water if required to satisfy permit limit.

1.2 Contractor SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submittals shall include:

1. A testing plan and schedule, including methods for water conveyance, control, disposal, and disinfection shall be submitted in writing for approval.

2. Name of certified bacteriological testing laboratory.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

A. Temporary valves, bulkheads, and other water control equipment and choice of disinfectant shall be as determined by the Contractor. No materials shall be used which would be injurious to the Work or future storage of potable water.

B. Chlorine for disinfection may be in the form of sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

1. Sodium and calcium hypochlorite shall be in accordance with ANSI/AWWA B300-Hypochlorites.

C. Dechlorination agents may be sodium bisulfate, sodium sulfite, or sodium thiosulfate.

PART 3 - EXECUTION

3.1 GENERAL

A. Water for testing and disinfecting will be furnished by the Owner; however, the Contractor shall convey the water from the Owner-designated source to the points of use.

B. All hydraulic structures and appurtenant pressure piping shall be tested; those for potable water shall also be disinfected by chlorination. The chlorinating and testing operations shall be performed in the presence of the Engineer.

C. In the case of a reservoir or tank, testing and disinfecting operations shall be combined.

D. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the Work is accepted by the Owner. Bacteriological testing shall be performed by a certified testing laboratory acceptable to the Owner. Results of the bacteriological testing shall be satisfactory to the State Department of Health or other appropriate regulatory agency.

E. Protective coating on the interior of steel reservoirs shall be applied before the combined testing and disinfecting operations.

F. Release of water from structures after testing and disinfecting have been completed shall comply with federal, state, and local regulations.

3.2 PRELIMINARY CLEANING AND FLUSHING

A. Prior to both testing and disinfecting, hydraulic structures shall be cleaned by thoroughly hosing down all surfaces with a high-pressure hose and nozzle of sufficient size to deliver a minimum flow of 50 gpm. Water, dirt, and foreign material accumulated in this cleaning operation shall be discharged from the structure or otherwise removed.

3.3 TESTING OF STEEL STRUCTURES

A. General: The test shall consist of filling the structure with water to the maximum operating water surface elevation and observing for visible leakage over a period of time.

B. Evaluation and Repairs: After the structure has been filled, record the water surface level in the structure from the level indicating transmitters (LITs) to the nearest hundredth of a foot. Monitor the water surface level in the structure for 7 days. After the tank has been filled for 7 days, outside surfaces shall be inspected for visible leakage. Leakage, as evidenced by liquid droplets, flowing water, or rusty stains, shall be repaired. The tank will not be accepted if any leakage as defined above is visible. Repaired tanks shall be retested, and if acceptable results are obtained, disinfection may proceed. Visible leak tests shall be performed during a period of dry weather. If precipitation occurs during the 7-day leak test, the test shall continue for an additional 7 days after the last precipitation event.

3.4 TESTING OF CONCRETE STRUCTURES

A. General: Testing shall be performed prior to backfilling. Testing shall not be performed sooner than 14 days after all portions of structure walls have been completed. The following structures shall be tested.

1. Solids Handling Pump Station (Area 50)

2. Solids Handling Basins (Area 60)

3. Clarified Backwash Pump Station (Area 70)

B. Leakage Test and Repairs: After the structure has been filled, the leakage test shall be performed as follows:

1. The structure shall be filled to the maximum operating water level indicated on the Drawings, or if not indicated or if the level will be controlled by a weir, fill the structure to the weir level or to the overflow elevation, whichever is higher.

    a. Each of the three solids handling basins shall be hydrostatically tested separately. Water used for testing one basin may be pumped to adjacent basins for testing.

2. Once full, record the water surface level to the nearest hundredth of a foot with the installed level indicating transmitter (LIT). For the solids handling basins, monitor the adjacent along the exposed walls for damp spots in the soil, dripping or other signs of leakage.

3. Measure and record initial water level readings at two locations that are approximately 180 degrees apart if the structure is circular or at opposite ends of the structure if the structure is rectangular.

4. Construct evaporation/precipitation devices as follows. A clear plastic calibrated open top container greater than 18-inches in diameter and in depth shall be partly filled with water, floated in the structure, and held in position at each measurement location but away from structure walls and items passing overhead such as beams or pipes. Measure the depth of water in the device.

5. Record the structure water levels and depths of water in the evaporation/precipitation devices at 24-hour intervals for a 7-day test period.

6. Each daily change in water surface elevation at each measurement point shall be adjusted by subtracting the change in water depth in the corresponding evaporation/precipitation device.

7. Acceptance Criteria: Both criteria apply.

    a. Allowable leakage

        1) Unlined concrete structures will pass the test if the water loss at the end of 7-days, as determined by averaging adjusted results at the two measurement locations, is equal to or less than 0.20 percent of the structure volume. Structures with multiple cells shall have the cells tested and evaluated individually.

        2) Lined concrete structures will pass the test if the water loss/gain at the end of 7-days equals that lost/gained due to evaporation/precipitation.

    b. No visible leakage appears during the 7-day test.

8. If intermediate readings or observed leakage indicate that the allowable leakage will be exceeded, the test may be terminated before the end of the 7-day period and appropriate action taken to correct the problem before starting a new 7-day test period.

9. If the structure fails the test, the Contractor may at its option repeat the test or empty the structure as acceptable to the Engineer and examine the interior for evidence of any cracking or other conditions that might be responsible for the leakage. Cracks shall be repaired in accordance with Section 03 01 00 – Maintenance of Concrete.

10. Following these operations, the Contractor shall again test the structure. The structure will not be accepted until the water loss leakage test is passed and all visible leakage repaired. In the case of a reservoir, the retesting shall again be combined with disinfection, exclusive of the spraying operation.

3.5 TESTING OF APPURTENANT PIPING

A. Piping appurtenant to hydraulic structures shall be tested in accordance with Section 33 05 05 – Pressure Pipe Testing and Disinfection.

3.6 DISINFECTION OF STRUCTURES AND APPURTENANT PIPELINES

A. Structures which store or convey potable water shall be disinfected by chlorination in accordance with the requirements of ANSI/AWWA C652 - Disinfection of Water Storage Facilities, using a combination of chlorination Methods 2 and 3 as modified herein, except that filter basins shall be disinfected in accordance with the requirements of ANSI/AWWA C653 - Disinfection of Water Treatment Plants.

B. Chlorination: A strong chlorine solution of approximately 200 mg/L shall be sprayed on all interior surfaces of the structure. Following this, the structure shall be partially filled with water to a depth of approximately one-foot. If the structure has a hopper bottom, fill it one-foot over the top of the hopper. During the partial filling operation, a chlorine-water mixture shall be injected by means of a solution-feed chlorinating device in such a way as to give a uniform chlorine concentration during the entire filling operation. The point of application shall be such that the chlorine solution will mix readily with the inflowing water. The dosage applied to the water shall be sufficient to provide a chlorine residual of at least 50 mg/L upon completion of the partial filling operation. Precautions shall be taken to prevent the strong chlorine solution from flowing back into the lines supplying the water. After the partial filling has been completed, sufficient water shall be drained from the lower ends of appurtenant piping to ensure filling the pipe with the heavily chlorinated water.

C. Retention Period: Chlorinated water shall be retained in the partially filled structure and appurtenant piping for at least 24 hours. Each valve shall be operated at least once from closed to full open to closed while the lines are filled with the heavily chlorinated water. After the chlorine-treated water has been retained for the required time, the free chlorine residual in the structure and appurtenant piping shall be at least 25 mg/L. If testing does not demonstrate a residual of 25 mg/L or greater, the disinfection procedure above shall be repeated.

D. Final Filling of Structure: After the free chlorine residual has been verified to satisfy the 25 mg/L requirement, the water level in the structure shall be raised to its final elevation by addition of potable water. Some heavily-chlorinated water shall be treated and released, if necessary, before final filling with potable water, such that the free chlorine residual after filling will be between 1 and 2 mg/L. After the structure has have been filled, the strength of the chlorinated water shall be determined. If the free chlorine residual is less than 1 mg/L, an additional dosage of chlorine shall be applied to the water. If the free chlorine residual is greater than 2 mg/L, the structure shall be partially emptied and additional potable water added. In no case shall water be released prior to the expiration of the required retention period.

3.7 BACTERIOLOGICAL SAMPLING AND TESTING

A. Disinfected water treatment and storage facilities shall be sampled and tested by a certified bacteriological laboratory.

3.8 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a one percent hypochlorite solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until all discolored water is eliminated.

END OF SECTION

SECTION 01 75 00 – EQUIPMENT TESTING AND PLANT STARTUP

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Plant startup is a prerequisite to satisfactory completion of the contract requirements and shall be completed within the Contract Times.

B. Conduct all test, check out, startup, and related requirements indicated in the Contract Documents and provide documentation of same to the Engineer prior to requesting Substantial Completion from the Engineer. Where manufacturer onsite inspections are required before startup, the manufacturer shall furnish a written statement that the installation and check out is complete and proper and that the item(s) are ready for startup

C. Startup of a treatment plant is a highly complex operation requiring the combined expertise of the Contractor, Subcontractors, Membrane System Supplier, Equipment Suppliers, the Engineer, and the Owner. The Contractor shall be responsible for coordinating all parties for a successful startup: the Engineer and Owner will be available for technical and operational advice prior to and during startup.

D. General requirements for startup activities are included in this Section. More specific requirements may also be included in other portions of the Contract Documents.

E. Temporary facilities may be necessary. If so, Contractor shall design, provide, operate, and later decommission them.

F. During startup, product water will be recycled using a clean water loop.

1.2 DEFINITIONS

A. Startup is defined as testing, demonstrations, and other activities as required to achieve Substantial Completion. Startup includes pre-commissioning and commissioning activities, manufacturer’s services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities.

B. Pre-commissioning is the systematic demonstration through testing and extended operation that major equipment and auxiliary systems, including related components, sub-systems, and systems operate properly and consistent with their intended function. Pre-commissioning involves balancing, adjustments, calibration, loop checks, and loop validation. Pre-commissioning shall simulate shutdown conditions, failure conditions, power fail and restart, bypass conditions, and failure resets. Pre-commissioning will not be considered complete until successful results and documentation of tests and manufacturer’s certifications required by the Contract Documents are submitted and accepted by the Engineer. Pre-commissioning of all portions of the Work shall be successfully completed prior to starting Commissioning.

C. Commissioning is the verification that the complete Work functions on an extended basis in full conformance with the Contract requirements.

1.3 SUBMITTALS

A. Schedule: The schedule for startup shall be submitted under Section 01 32 14 – Barchart Construction Schedule.

B. Startup Plan: Not less than 60 Days prior to startup, Contractor to submit for review a detailed Startup Plan. The Contractor shall revise the Plan as necessary based on review comments. The Plan shall include:

1. Schedules for manufacturers' equipment certifications

2. Schedules for submitting final Technical Manuals,

3. Schedule for training the Owner's personnel,

4. Description of temporary facilities and schedule for installation and decommissioning them

5. List of Owner and Contractor-furnished supplies

6. Detailed schedule of operations to achieve successful pre-commissioning and commissioning.

7. Checklists and data forms for each item of equipment

8. Address coordination with the Owner's staff and define roles and responsibilities for the Contractor, Engineer, and Owner.

9. Designate a representative of the Contractor who has the authority to act in matters relating to startup and has experience in testing Microfiltration Membrane Systems, Onsite Sodium Hypochlorite Generation Systems and pumps. The Plan shall also designate the roles and responsibilities of any Subcontractors, the membrane system supplier, and any other party that may be involved in startup activities.

10. Safety, startup, and testing procedures and proposed inspection and certification forms and records.

11. Interconnection of new to existing facilities

    a. Date and time frame of proposed shutdown or interconnection, including sequence of events and activities to be conducted.

    b. A detailed description of sequences and activities for the planned shutdown and interconnection.

    c. Staff, equipment, and materials that will be at the Site before commencing the shutdown.

    d. Other provisions so that interconnection, testing, and startup will be completed within the planned time.

12. Hydrostatic testing of water-holding structures and pipelines and other potable water equipment. Schedule and plan shall indicate source of water, testing and disinfection sequence, disinfection procedures, and the disposal of the water following disinfection.

    a. Refer to Section 01 74 10 – Testing and Disinfection of Concrete and Steel Water Structures, and

    b. Refer to Section 33 05 05 – Pressure Pipe Testing and Disinfection

C. System Outage Requests: Request for shutdown of existing systems as necessary to test or start up new facilities. Refer to 01 10 00 - Summary of Work for allowable interruptions and minimum recover between interruptions..

D. Records and Documentation

1. Where required by the specifications, submit equipment installation certifications under those Sections.

2. Records of startup as indicated below.

E. NSF 60 certifications for treatment chemicals.

1.4 REFERENCE SPECIFICATIONS

A. NSF / ANSI 60: Drinking Water Treatment Chemicals - Health Effects

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 MALFUNCTIONS

A. During the extended operational demonstrations, all components, subsystems, systems, and equipment must properly run continuously 24 hours per day at rates indicated by the Engineer throughout the test period. Unless indicated otherwise, if any item fails or malfunctions during the test, the item shall be repaired and the test restarted at time zero with no credit given for the operating time before the failure or malfunction. Malfunctions satisfying all 3 of the following conditions will allow the demonstration period to resume at the elapsed time when the malfunction started:

1. Malfunction did not cause any interruption of the continuous operation of any other components, subsystems, systems, and equipment.

2. Malfunction was corrected without causing or requiring any components, subsystems, systems, and equipment to cease operations.

3. Malfunction was corrected within one hour of the time the malfunction was detected (the one hour period includes the time required to locate the cause of the malfunction, beginning upon Contractor’s notification from the Engineer that a malfunction has occurred and ending when the item is corrected and the system is successfully placed back into operation).

B. The Contractor shall arrange for manufacturer's representatives to visit the Site as often as necessary to correct malfunctions.

3.2 PREREQUISITES

A. Pre-commissioning and commissioning activities shall be scheduled according to Section 01 32 14 – Barchart Construction Schedule. The 7 Day demonstrations and the 8 Day demonstration shall start prior to midday on a Monday, Tuesday, or Wednesday. Testing periods shall not include holidays, based on the Owner's calendar.

B. The following shall be completed before pre-commissioning begins.

1. All Technical Manual information required by the Contract Documents has been submitted.

2. Safety equipment, emergency shower and eyewash units, fire extinguishers, gas detectors, protective guards and shields, emergency repair kits, safety chains, handrails, gratings, safety signs, and valve and piping identification required by the Contract Documents are provided. Devices and equipment shall be fully functional, adjusted, and tested.

3. Verification of completion of each Definable Feature of Work identified in the Contract Documents.

4. Manufacturer's certifications of proper installation have been accepted.

5. Completion and acceptance of all inspections and test that are required during the construction phase.

6. Leakage tests, electrical tests, and adjustments have been completed.

7. Disinfection, flushing, and testing of potable water pipelines, concrete and steel water structures in accordance with Specification Sections 01 74 10 – Testing and Disinfection of Concrete and Steel Water Structures and 33 05 05 – Pressure Pipe Testing and Disinfection.

8. The Engineer has approved the Startup Plan.

9. Temporary facilities are functional, adjusted, and ready for use.

10. Individual instrumentation loops (analog, status, alarm, and control) have been verified functionally.

11. Pressure switches, flow switches, timing relays, level switches, vibration switches, temperature switches, RTD monitors, pressure regulating valves, and other control devices to the settings determined by the Engineer or the equipment manufacturer have been adjusted for accuracy.

12. Individual interlocks between the field-mounted control devices and the motor control circuits, control circuits of variable-speed controllers, and packaged system controls have been verified.

3.3 GENERAL

A. Supplies

1. The Contractor shall furnish and install the following:

a. Chemicals

1) Supply NSF 60 certified chemicals of the following quantities for bulk chemical fills.

a) 1, 400 gallon bulk delivery of Aluminum Chlorohydrate (ACH) to be stored in the ACH tank. Provide by bulk chemical truck and install in Owner's tank.

b) 1, 400 gallon bulk delivery of Sodium Hydroxide (SDH) to be stored in the Sodium Hydroxide Storage Tank. Provide by bulk chemical truck and install in Owner's tank.

c) 1, 55 gallon delivery of Calcium Thiosulfate.

d) 1, 330 gallon tote delivery of Citric Acid.

2) At least one pallet of 40lb salt bags. The number of bags is estimated to be 56.

b. Fuel

c. Oil and grease

d. Other necessary materials not listed for the Owner to furnish

2. The Owner will furnish:

a. Water

b. Power

B. Startup Records: The Contractor shall maintain the following during testing and startup and submit originals to Engineer:

1. Lubrication and service records for each mechanical and electrical equipment item

2. Hours of daily operation for each mechanical and electrical equipment item

3. Equipment alignment and vibration measurement records

4. Logs of electrical measurements and tests

5. Instrumentation calibration and testing logs

6. Testing and validation of SCADA inputs, outputs, logic functions, status indications, and alarms

7. Factory and field equipment settings

8. Log of problems encountered and remedial action taken

9. Other records, logs, and checklists as required by the Contract Documents

3.4 PRE-COMMISSIONING

A. After individual equipment items and subsystems have been tested and certified as required by the Technical Specifications, tests of systems comprised of single or multiple equipment items with appurtenant equipment and instruments and controls shall be conducted. Items of equipment shall be tested as part of a system to the maximum extent possible.

B. Subject to the malfunction criteria above, each system shall be demonstrated for a continuous, 7 Day, 24 hour/day period. If any system malfunctions, the item or equipment shall be repaired and the test restarted at time zero with no credit given for the elapsed time before the malfunction.

C. The Contractor shall demonstrate the manual and automatic modes of operation to verify proper control sequences, software interlocks, proper operation of software logic and controllers, etc. System testing shall include the use of water or other process media, as applicable, to simulate the actual conditions of operation.

D. Systems testing activities shall follow the detailed procedures and checklists in the Testing and Startup Plan. Completion of systems shall be documented by a report.

E. The Contractor shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.

F. Furnish the Engineer at least 10 Days written notice confirming the start of pre-commissioning. The Engineer or Owner's staff will observe pre-commissioning.

G. Pre-Commissioning Testing: The Contractor shall:

1. Perform checkout and function testing as specified in the individual equipment sections and the Contract.

2. Functionally test mechanical and electrical equipment and instrument and controls systems for proper operation after installation testing tasks have been completed.

3. Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration. Perform initial checks in the presence of and with the assistance of the manufacturer’s representative.

4. Demonstrate the equipment is effectively communicating with each other.

H. Certification of Proper Installation

1. At completion of Function Testing, the Contractor shall furnish comprehensive certified test record documentation, prepare and signed by manufacturer's authorized representative, by the electrical and/or instrumentation subcontractor, certifying the following for all components, devices, equipment, subsystems, systems, facilities, controls, and processes:

    a. Has been properly installed, adjusted, aligned, and lubricated

    b. Is free of stresses imposed by connecting piping or anchor bolts

    c. Is suitable for satisfactory full-time operation under full load conditions

    d. Operates within the allowable limits for vibration

    e. Motor control logic that resides in motor control centers, control panels, and circuit boards furnished by the electrical and/or instrumentation subcontractor has been fully configured and tested and is properly operating

    f. Controls, protective devices, instrumentation, and control panels furnished as part of the equipment package are properly installed, calibrated, and functioning.

    g. Control logic for start-up, shutdown, sequencing, interlocks, and emergency shutdown have been tested and are properly functioning. Note: this is limited to local controls only (i.e. – communicating with the PLC but independent of the PLC programming).

    h. A Manufacturer's Certificate of Proper Installation form, a copy of which is attached to this section, shall be completed and signed by the equipment manufacturer's representative.

    i. Other sign-off sheets will be furnished by the Engineer prior to initiation of Functional Testing.

    j. The certified test records shall include documentation of all pre-commissioning and commissioning activities and tests, studies, compliance certificates, and other records required by the specifications.

3.5 COMMISSIONING

A. The Contractor shall start up the plant and operate it without malfunction for a continuous 8 Day, 24 hour/day period. The Engineer will determine the operational parameters.

B. Upon approval of the Engineer's commissioning testing and pre-start-up activities, the Contractor shall prepare the site for and perform facility start-up testing that includes the following:

1. The Contractor shall be responsible for installing temporary piping, valves, pumps, and other appurtenances (including electrical) that will be required for the start-up and commissioning of the facility. The detailed plan will be developed prior to construction. Temporary facilities shall be removed completed at the end of the project.

2. Process area start-ups: where possible and beneficial to reduce complexity and risk of complete facility testing, start-up individual process areas comprised of multiple interdependent systems. Process area test flows will be limited by upstream, and downstream process constraints (i.e., tank and basin volumes) and/or localized recirculation capabilities

3. Defects that appear shall be promptly corrected. Time lost for wiring corrections, control point settings, or other reasons that interrupt the test may, at the judgement of the Engineer, be cause for extending the demonstration an equal amount of time.

4. Commissioning shall not begin until leakage tests, instrumentation tests and adjustments, electrical tests and adjustments, equipment field tests, disinfection, and system tests have been completed to the satisfaction of the Engineer.

5. System testing with water – no treatment: test entire facility with recirculating water supply at the design flow for the largest single process or system train to ensure proper complete facility (devices, components, equipment, and controls) hydraulic performance.

6. During commissioning, the Contractor shall lubricate and maintain equipment in accordance with the manufacturers' recommendations.

7. Perform to the extent possible control testing and control loop tuning during system testing with water, control testing, interlock and permissive testing, etc.

8. Systems testing activities shall follow the detailed procedures and checklists in the Startup and Commissioning Plan. Completion of systems shall be documented by a final report and submitted to the Owner.

9. The Contractor shall demonstrate utility, chemical feed, safety equipment, and other support systems before whole process systems.

C. Upon completion of start-up testing, the Contractor shall perform entire facility start-up resulting in treatment of raw water delivered from the raw water conveyance system. The Contractor will also complete remaining control loop tuning and interlock permissive testing during this phase of start-up.

D. The Contractor shall conduct remaining equipment, subsystem, and system performance tests as specified that could not be performed during the commissioning phase due to inter system and/or treatment process dependencies.

E. The Owner will furnish certified treatment plant operators during the startup period to comply with Washington Department of Health requirements. Certified operators will be under the direct supervision of and be responsible to the Contractor. The Contractor shall furnish continuous staffing at the facility for the commissioning period.

END OF SECTION

SECTION 01 77 00 – PROJECT CLOSEOUT

PART 1 -- GENERAL

1.1 FINAL CLEANUP

A. The Contractor shall promptly remove from the vicinity of the completed Work, all rubbish, unused materials, concrete forms, construction equipment, and temporary structures and facilities used during construction. Final acceptance of the Work by the Owner will be withheld until the Contractor has satisfactorily performed the final cleanup of the Site.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures

1.3 CLOSEOUT TIMETABLE

A. The Contractor shall establish dates for equipment testing, acceptance periods, and on-site instructional periods (as required under the Contract). Such dates shall be established not less than one week prior to beginning any of the foregoing items, to allow the Owner, the Engineer, and their authorized representatives sufficient time to schedule attendance at such activities.

1.4 TECHNICAL MANUAL SUBMITTAL

A. The Contractor's attention is directed to the condition that one percent of the Contract Price will be retained from any monies due the Contractor as progress payments, if at the 75 percent construction completion point, the approved Technical Manual complying with Section 01 33 00 – Submittal Procedures has not been submitted. The aforementioned amount will be retained by the Owner as the agreed, estimated value of the approved Technical Manual. Any such retention of money for failure to submit the approved Technical Manual on or before the 75 percent construction completion point shall be in addition to the retention of any payments due to the Contractor under Article 15 of the General Conditions.

1.5 FINAL SUBMITTALS

A. The Contractor, prior to requesting final payment, shall obtain and submit the following items to the Engineer for transmittal to the Owner:

1. Written guarantees, where required.

2. Technical Manuals and instructions.

3. New permanent cylinders and key blanks for all locks.

4. Maintenance stock items; spare parts; special tools.

5. Completed record drawings.

6. Bonds for roofing, maintenance, etc., as required.

7. Certificates of inspection and acceptance by local governing agencies having jurisdiction.

B. Evidence of payment and release of liens in accordance with conditions of the Contract.

C. Consent of Surety to final payment.

D. Releases from all parties who are entitled to claims against the subject project, property, or improvement pursuant to the provisions of law.

1.6 MAINTENANCE AND GUARANTEE

A. The Contractor shall comply with the maintenance and guarantee requirements contained in Article 15 of the General Conditions.

B. Replacement of earth fill or backfill, where it has settled below the required finish elevations, shall be considered as a part of such required repair work, and any repair or resurfacing constructed by the Contractor which becomes necessary by reason of such settlement shall likewise be considered as a part of such required repair work unless the Contractor shall have obtained a statement in writing from the affected private owner or public agency releasing the Owner from further responsibility in connection with such repair or resurfacing.

C. The Contractor shall make all repairs and replacements promptly upon receipt of written order from the Owner. If the Contractor fails to make such repairs or replacements promptly, the Owner reserves the right to do the Work and the Contractor and its surety shall be liable to the Owner for the cost thereof.

1.7 BOND

A. The Contractor shall provide a bond to guarantee performance of the provisions contained in Paragraph "Maintenance and Guarantee" above, and Article 15 of the General Conditions.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION (NOT USED)

END OF SECTION

SECTION 01 79 00 - OWNER STAFF TRAINING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall furnish all labor, materials, equipment, and incidentals necessary to train Owner's personnel on the equipment, products, and systems furnished under this Contract. Owner training is a prerequisite to satisfactory completion of the Contract requirements and shall be completed within the Contract Time.

B. Training for the membrane system is described in Section 01 73 00 – Training of Operations and Maintenance Personnel. This Section shall be for the balance of equipment.

C. The minimum onsite training requirements for various plant components are described in various sections of the specifications.

D. Except where otherwise indicated, all costs for training shall be the responsibility of the Contractor.

1.2 SUBMITTALS

A. Training Schedule: Schedule for training the Owner's personnel shall be submitted with the detailed Testing and Startup Plan required by Section 01 75 00 – Equipment Testing and Plant Startup.

B. Resumes of instructors.

C. The training lesson plan and materials shall be submitted to the Engineer for review at no later than the progress payments for 50 percent of the Contract Price.

D. Approved operation and maintenance manuals shall be available at least 30 days prior to the scheduled date for the individual training session.

E. Training classes shall be scheduled a minimum of four (4) weeks in advance of the date of the first class to allow Owner staffing arrangements to take place. The Contractor shall schedule training classes within the period 8:00 a.m. to 5:00 p.m. Monday through Friday.

F. Training classes shall be organized in conjunction with the Startup Systems, as defined in Section 01 75 00 – Equipment Testing and Plant Startup. Each training class shall consist of a classroom portion and a field tour portion. Each training class shall include:

1. Safety to be conducted by the plant safety officer.

2. Overview of the startup system, conducted by the Engineer.

3. Training on each item of equipment within the startup system, conducted by the Equipment Manufacturer's representative.

4. Training on the mechanical piping system within the startup system, conducted by the Contractor's mechanical superintendent.

5. Training on the power distribution system within the startup system, conducted by the Contractor's electrical superintendent.

6. Training on the instrumentation and control systems within the startup system, conducted by the Contractor's I&C System Supplier.

7. Training on the SCADA control system within the startup system, conducted by the Contractor's I&C System Supplier.

8. Training on the Membrane Filtration system within the startup system, conducted by the Membrane supplier.

G. Class Agenda: A class agenda shall be prepared by the Contractor and submitted to the Engineer with the training schedule. The agenda shall include a listing of subjects to be discussed, time estimated for each subject, a list of documentation to be used and provided to support training, the proposed route of the field tours, and the instructor(s) name and qualifications. Agendas shall include an allocation of time for all components of the training session, including time for Owner staff to ask questions and discuss the subject matter. The Owner may request that particular subjects are emphasized and the agenda shall be adjusted to accommodate these requests. Copies of the agenda shall be distributed to each student at the beginning of each training class.

H. Within ten (10) days after the completion of each training session, the Contractor shall submit the following:

1. A sign-in sheet of all personnel that attended the training session, including the instructor and any witnesses.

2. A copy of the training materials utilized during the lesson with all notes, diagrams, and comments.

I. All information provided in the class, in PDF or Microsoft compatible formats.

1.3 INSTRUCTOR QUALIFICATIONS

A. Instructors shall be completely knowledgeable in the products and systems for which they are providing training, and shall be experienced in conducting classes. Sales representatives are not considered qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.

B. Instructor shall have at least two years of experience in providing training certified by the Manufacturer.

C. If, in the opinion of the Owner, the Instructor did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor at the Contractor's expense.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Where specified, the Contractor shall conduct training sessions for the Owner's personnel to instruct the staff on the proper operation, care, and maintenance of the equipment and systems installed under this Contract.

2.2 TRAINING AIDS

A. Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, or other means to effectively increase the transfer of knowledge. The instructor conducting the training shall furnish all such equipment (televisions, projectors, screens easels, etc.), models, and charts for each class. It shall be the responsibility of the instructor to confirm in advance that the class room will be appropriate for the types of audio-visual equipment to be employed.

2.3 LOCATION

A. Training sessions shall take place at location specified by the Owner, except for field training on the actual equipment which shall occur at the Project Site.

2.4 FORMAT AND CONTENT

A. Use approved Operation and Maintenance (O&M) Manual(s) as the basis for instruction. Review contents of manuals with personnel in detail to explain all aspects of operation and maintenance. Prepare and insert additional data in O&M Manuals when need for such data becomes apparent during instruction. Promotional information will not be accepted. Power Point, handouts and hands-on instruction are encouraged. Simply reading from the O&M manual is not an acceptable training method.

B. Each training session shall be comprised of time spent both in the classroom and at the specific location of the subject equipment or system. As a minimum, training session shall cover the following subjects for each item of equipment or system:

1. Familiarization

    a. Review catalog, parts lists, drawings, etc., which have been previously provided for the Owner's files and operation and maintenance manuals.

    b. Inspection on how the equipment has been installed. Demonstrate the operation of the unit and describe how all parts of the equipment meet the requirement of the Specifications.

    c. Answer questions.

2. Safety

    a. Using material previously provided, review safety features of the equipment.

    b. Discuss proper precautions when working around equipment.

3. Operation

a. Using material previously provided, review reference literature.

b. Explain all modes of operation (including emergency).

c. Check out Owner's personnel on proper use of the equipment.

4. Preventive Maintenance

   a. Using material previously provided, review preventive maintenance (PM) lists including:

      1) Reference material.

      2) Daily, weekly, monthly, quarterly, semiannual, and annual PM activities.

   b. Demonstrate how to perform Preventive Maintenance procedures.

   c. Demonstrate to the Owner's personnel what to look for as indicators of potential equipment problems.

5. Corrective Maintenance

   a. Identify possible problems.

   b. Demonstrate how to perform repairs. Point out special problems.

   c. Open up equipment and demonstrate O&M procedures, where practical.

6. Parts

   a. Demonstrate the use of previously provided parts list and order parts.

   b. Check over spare parts on hand. Make recommendations regarding additional parts that should be available.

7. Local Representatives

   a. Identify local vendors where to order parts: name, address, telephone.

   b. Service problems:

      1) Identify contacts local contacts.

      2) Identify emergency contacts.

8. Operation and Maintenance Manuals

   a. Review any other material submitted.

   b. Update material, as required.

PART 3 -- EXECUTION

3.1 GENERAL

A. The objective of the training included under this Section shall be to convey the knowledge needed by the Owner operations, maintenance, and engineering staff to safely operate, maintain, and repair the equipment and systems furnished under this Contract.

B. Owner personnel who will participate in this training have existing full-time work assignments and this training is an additional assigned work task. Owner's staff work schedules regularly shift, as the plant is operated on an around-the-clock basis.

C. Training shall be tailored to suit the skills and job classifications of the personnel attending the classes e.g., plant manager, plant operator, maintenance technical, electrician, etc.

D. Minimum onsite training requirements for plant components are described in various sections of the Specifications. For the purpose of the times given in individual Specification sections, a workday is defined as an eight (8) hour day at the site, excluding travel time.

E. Training shall be scheduled as a separate trip from equipment inspection, startup, and field adjustment. Training shall not be done until the manufacturer certifies that the equipment is operable as specified.

F. Satisfactorily complete functional testing before beginning training sessions. Training will be conducted prior to process startup of associated systems or equipment.

G. Specific Training Objectives: The training shall include a review of the equipment and drives, including internal parts, as prepared at the factory. The training shall include safety, removal, inspection, cleaning, operation and maintenance of the equipment such as startup, normal operation and shutdown procedures, step-by-step troubleshooting procedures with all necessary test equipment, and emergency or abnormal operation procedures. Training shall include preventive maintenance and long-term maintenance procedures, special tools necessary, and a discussion of recommended spare parts.

3.2 TRAINING CLASSES

A. Number of Classes on Each Subject: A minimum of two (2) classes on identical subject matter shall be conducted, unless otherwise indicated. The purpose of having two (2) classes on each subject is to accommodate the attendance of as many Owner personnel working different shifts as possible.

B. A maximum of one (1) class per day shall be held on consecutive days unless otherwise approved by the Owner. Multiple classes may be scheduled if the class duration is shorter than four (4) hours. Times shall be scheduled at the discretion of the Owner.

C. Class Length: Each class shall be subdivided into two (2) to six (6) hour modules, or as appropriate for the subject matter being discussed.

D. Number of Students: It is estimated that five (5) to ten (10) persons will attend each training class. The Owner will determine the actual number of students. Provide training materials for all attendees.

E. Cancellation of Classes: If a class must be canceled because the equipment is not ready for operation, etc. the Contractor shall notify the Owner at least one (1) week in advance. The Contractor shall coordinate with the Owner to reschedule the training.

3.3 TRAINING AIDS

A. Training Aids: Each instructor is encouraged to use audio-visual devices, P&IDs, models, charts, etc. to increase the transfer of knowledge. The Contractor shall provide all such equipment (televisions, DVD player, projectors, screens, easels, models, charts, etc.) for each class. It shall be the responsibility of the Contractor to confirm in advance that the training room set-up will be appropriate for the types of audiovisual equipment to be employed.

B. Classroom Documentation: If training is being completed on equipment, systems, or products for which a Technical Manual is required, the draft Technical Manual shall have been returned by the Engineer with a status of “No Exceptions Taken” or “Make Corrections Noted” before the training class is scheduled. The approved Technical Manual shall be used during the classroom instruction. Supplemental documentation handouts shall be provided by the organization conducting the training as required to the support instruction.

3.4 DOCUMENTATION OF TRAINING

A. The Contractor shall videotape the entire detailed training course in proper operation and maintenance and provide the video in an online digital format or DVD format. The video shall be organized by each segment of the training session and be presented in a table of contents style with selectable segments of the session. The videotape shall become the exclusive property of the Owner. The Owner reserves the right to videotape, photograph, audio record, and otherwise document any or all training classes provided under this WORK.

B. The following services shall be provided for each item of equipment or system as required in individual specification sections. Additional services shall be provided, where specifically required in individual specification sections.

1. As a minimum, classroom equipment training for operations personnel will include:

a. Identify and discuss safety items and procedures.

b. Using slides and drawings, discuss the equipment's specific location in the plant and an operational overview.

c. Purpose and plant function of the equipment.

d. A working knowledge of the operating theory of the equipment.

e. Start-up, shutdown, normal operation, and emergency operating procedures, including a discussion on system integration and electrical interlocks, if any.

f. Routine preventative maintenance, including specific details on lubrication and maintenance of corrosion protection of the equipment and ancillary components.

g. Operator detection, without test instruments, of specific equipment trouble symptoms.

h. Required equipment exercise procedures and intervals.

i. Routine disassembly and assembly of equipment if applicable (as judged by the Owner on a case-by-case basis) for purposes such as operator inspection of equipment.

2. As a minimum, hands-on equipment training for operations personnel will include:

a. Identify and review safety items and perform safety procedures.

b. Identify location of equipment and review the purpose.

c. Identifying piping and flow options.

d. Identifying valves and their purpose.

e. Identifying instrumentation.

f. Location of primary element.

g. Location of instrument readout.

h. Discuss purpose, basic operation, calibration, maintenance, troubleshooting, repair, and information interpretation.

i. Discuss, demonstrate, and perform standard operating procedures and round checks.

j. Discuss and perform the preventative maintenance activities.

k. Discuss and perform start-up and shutdown procedures.

l. Perform the required equipment exercise procedures.

m. Perform routine disassembly and assembly of equipment if applicable.

3. Classroom equipment training for the maintenance and repair personnel will include:

a. Safety procedures.

b. Theory of operation.

c. Description and function of equipment.

d. Start-up and shutdown procedures.

e. Normal and major repair procedures.

f. Equipment inspection and troubleshooting procedures including the use of applicable test instruments and the "pass" and "no pass" test instrument readings.

g. Routine and long-term calibration procedures.

h. Preventative maintenance such as lubrication; normal maintenance such as belt, seal, and bearing replacement; and up to major repairs such as replacement of major equipment part(s) with the use of special tools, bridge cranes, welding jigs, etc.

i. Hands-on equipment training for maintenance and repair personnel shall include:

1) Locate and identify equipment components.

2) Review the equipment function and theory of operation.

3) Review normal repair procedures.

4) Perform start-up and shutdown procedures.

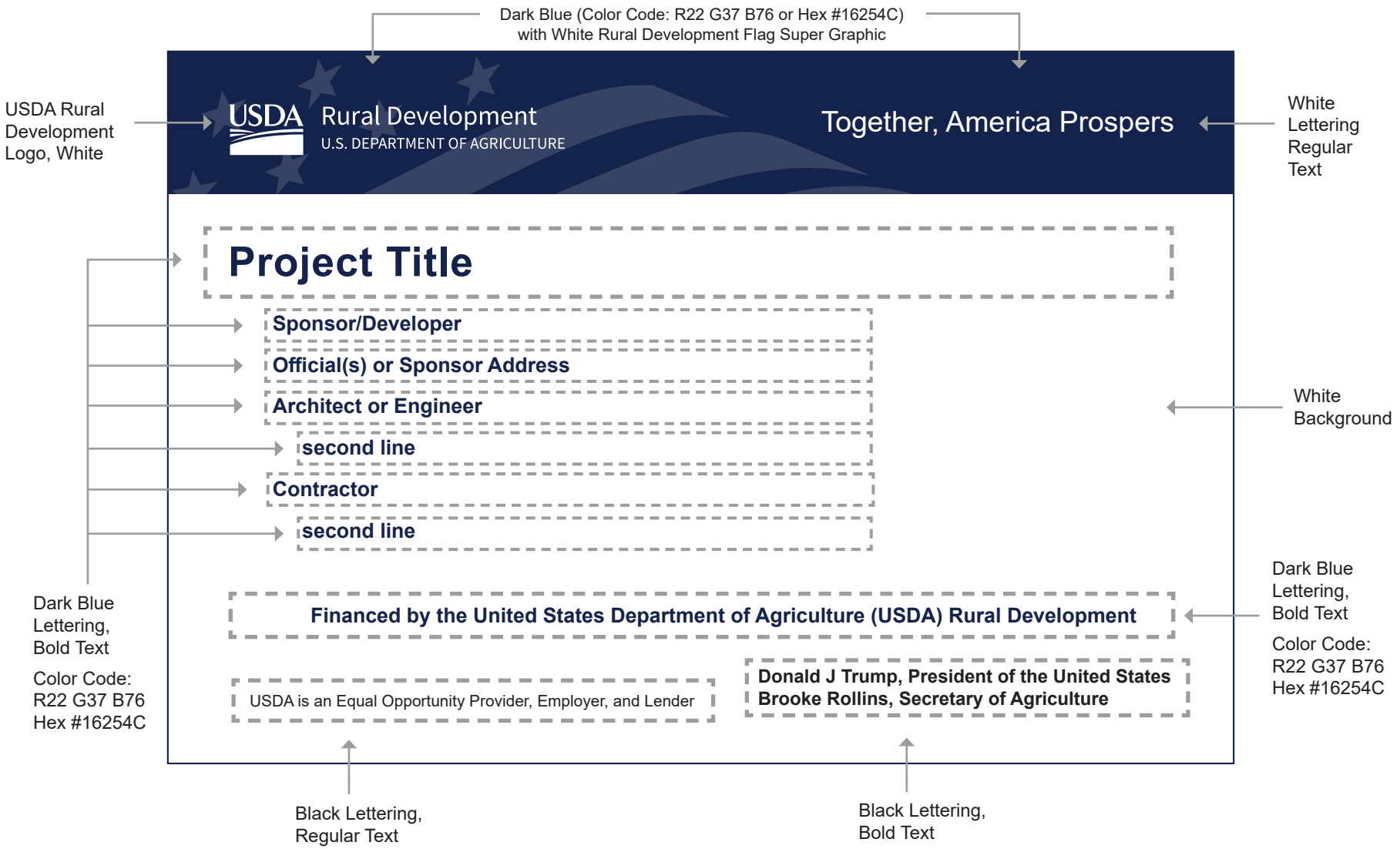
5) Review and perform the safety procedures.

6) Perform Owner-approved practice maintenance and repair job(s), including mechanical and electrical adjustments and calibration and troubleshooting equipment problems.

END OF SECTION

Temporary Construction Sign for Rural Development Projects

Recommended Font: Arial



SIGN DIMENSIONS: 1200mm x 2400mm x 19mm (approx.4’ x 8’ x 3/4)
PLYWOOD PANEL (APA RATED A+B GRADE-EXTERIOR)

SECTION 02 41 00 – DEMOLITION

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required for demolitions of existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation facilities as indicated, in accordance with the Contract Documents.

1.02 COORDINATION

A. The Contractor shall carefully coordinate the Work in areas where existing facilities are interconnected with new facilities and where existing facilities remain operational. The Work as indicated is not all-inclusive, and the Contractor shall be responsible to perform the reconstruction indicated plus that which can be reasonably inferred from the Contract Documents as necessary to complete the Project. The Specifications and Drawings identify the major facilities that shall be demolished and reconstructed, but auxiliary utilities such as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily shown. The Contractor shall comply with sequencing requirements in Section 01 14 00 - Construction Constraints.

B. The Contractor shall note that the Drawings used to indicate demolition and reconstruction are based on survey of surface features, record information, and site photographs provided describing the existing facilities. The record information has been reproduced in the Drawings to show existing conditions and to clarify the scope of Work. The information provided may not be complete or accurate. The Contractor shall conduct a comprehensive survey at the Site to verify the correctness and exactness of the Drawings, the scope of Work, and the extent of auxiliary utilities.

C. While demolition and reconstruction are being performed, the Contractor shall provide adequate access for the continued operation and maintenance of equipment and treatment processes. The Contractor shall erect and maintain fences, warning signs, barricades, and other devices around the reconstruction as required for the protection of the Contractor's employees and the Owner's personnel at the plant. The Contractor shall remove such protection when reconstruction activities are complete, or as Work progresses, or when requested by the Engineer.

D. The Contractor shall be responsible for acquiring appropriate necessary permits for the work. Copies of the permits shall be submitted to the Owner prior to commencement of demolition.

1.03 CONTRACTOR SUBMITTALS

A. A demolition plan shall be submitted to the Engineer for review. The demolition plan shall detail demolition and reconstruction activities and procedures, including operational sequences, in accordance with Section 01 33 00 – Submittal Procedures. The procedures shall provide for safe conduct of the Work, careful removal and disposition of materials and equipment, protection of existing facilities which are to remain undisturbed, coordination with existing facilities to remain in service, and timely disconnection and reconnection of utility services. The procedures shall include a detailed description and time schedule of the methods and equipment to be used for each operation and the sequence of operation.

B. The demolition plan shall include identification of items to be salvaged or relocated. A storage plan for salvaged items shall be included.

C. The Engineer's review shall be limited to a review of the scope and intent of demolition as required by the contract documents. The Contractor shall be responsible for the means and methods to ensure the work is conducted in a safe and proper manner. The Engineer's review of the demolition plan shall in no way alleviate the Contractor from this responsibility.

D. Protection:

1. Perform all demolition and removal Work to prevent damage or injury to structures, occupants thereof and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.

2. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.

3. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices.

4. Repair damage to facilities to remain, or to any property belonging to the Owner or occupants of the facilities.

E. Scheduling:

1. Carry out operations to avoid interference with Owner's operations and Work in the existing facilities.

F. Notification:

1. At least 48 hours prior to commencement of a demolition or removal activity, notify the Engineer in writing of the proposed schedule. The Owner will inspect the existing equipment and mark for identification those items which are to remain the property of the Owner. Do not start removals without the permission of the Engineer.

G. Explosives:

1. Do not bring explosives onto site.

2. The use of explosives will not be permitted.

1.04 REFERENE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 14 00	Construction Constraints
01 33 00	Submittal Procedures
01 50 10	Protection of Existing Facilities

09 96 00.10	High Performance Coatings
31 30 00	Earthwork

1.05 DEMOLITION

A. Existing structures, equipment, piping, valves, ductwork, electrical gear, instrumentation, utilities, and related appurtenances such as anchors, supports, and hardware indicated or required to be demolished as part of the Work shall be removed and disposed of unless otherwise indicated. Removal of buried structures, utilities, and appurtenances includes the related excavation and backfill as required. Removed items shall be disposed of offsite by the Contractor.

B. Items to be removed include:

Item	**Description**
Chain Link Fencing	Demolish and remove existing chain link fencing and in accordance with the Contract Drawings
Raw Water Ultrasonic Flowmeter and Raw Water Chemical Injection Piping	Demolish and remove existing ultrasonic flowmeter, existing raw water chemical injection piping, and existing raw water pipe in the raw water vault as indicated on the Contract Drawings
Rapid Rate Gravity Filters	Demolish and remove existing washwater trough, surface agitators, and PVC laterals.
Filter Backwash Piping	Demolish and remove existing 8” Backwash piping as indicated on Drawings. Seal concrete penetrations as indicated on the Contract Drawings.
Clarified Water Effluent Control Valves	Demolish and remove existing 4” control valves. Blind flange or install 4” Butterfly Valves according to the Contract Drawings.
Filter Backwash Control Station	Demolish and remove existing filter backwash control panel and building as indicated on the Contract Drawings.
Filter Surface Backwash Pump	Demolish and remove existing filter backwash surface pump, associated pipes, valves and instrumentation as indicated on the Contract Drawings.
SumaClear Chemical System	Demolish and remove existing SumaClear chemical tank, tank mixer, pumps, associated piping, valves, and instrumentation as indicated on the Contract Drawings
Chlorine Chemical System	Demolish and remove existing Chlorine tank, pumps, associated piping, valves and instrumentation as indicated on the Contract Drawings.

1.06 ABANDONMENT

A. Items of existing equipment, piping, valves, electrical gear, instrumentation, utilities, and appurtenances to be abandoned shall be prepared by the Contractor as indicated.

B. Items to be abandoned include:

Item	Description
Filtered Water Yard Piping	Cap and abandon filtered water yard piping in accordance with the Contract Drawings

1.07 REHABILITATION

A. Existing civil, landscaping, structural, architectural, mechanical, HVAC, electrical, and instrumentation Work disturbed or damaged by reconstruction activities shall be repaired and rehabilitated as indicated.

B. Damaged items shall be repaired or replaced with new items to restore items or surfaces to a condition equal to and matching that existing prior to damage.

C. In buildings with reconstruction Work, the Contractor shall not use any Owner equipment (e.g., bridge cranes and monorails) unless authorized in advance in writing by the Engineer. Such authorization shall be subject to documentation by the Contractor of the proposed load on the equipment and be subject to Owner requirements for usage on operating and maintenance needs. Any damage to a crane shall be repaired or replaced to the Engineer's satisfaction.

1.08 DISPOSAL

A. The Contractor shall be responsible for the offsite disposal of debris resulting from reconstruction in compliance with local, state, and federal codes and requirements.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 GENERAL

A. The Contractor shall coordinate demolition and reconstruction Work with the Owner and Engineer. Unless otherwise indicated, the Contractor shall be responsible for the sequence of activities. Work shall be performed in accordance with applicable safety rules and regulations.

B. The Contractor shall verify that any utilities connected to structures, equipment, and facilities to be removed, relocated, salvaged, replaced, or abandoned are rendered inoperable, replaced with new utilities, or adequately bypassed with temporary utilities before proceeding with demolition and reconstruction.

C. The Contractor shall take precautions to avoid damage to adjacent facilities and to limit the Work activities to the extent indicated. If reconstruction beyond the scope indicated is required, the Contractor shall obtain approval from the Engineer prior to commencing.

3.02 PROTECTION OF EXISTING FACILITIES

A. Before beginning any reconstruction, the Contractor shall carefully survey the existing facilities and examine the Specifications and Drawings to determine the extent of reconstruction and coordination with the Work. Existing facilities not subject to reconstruction shall be protected and maintained in accordance with Section 01 50 10 - Protection of Existing Facilities. Damaged existing facilities shall be repaired to the previous condition or replaced.

B. Persons shall be afforded safe passages around areas of demolition.

C. Structural elements shall not be overloaded. The Contractor shall be responsible for shoring, bracing, or adding new supports as may be required for adequate structural support as a result of Work performed under this Section. The Contractor shall remove temporary protection when the Work is complete or when so authorized by the Engineer.

D. The Contractor shall carefully consider bearing loads and capacities before placement of equipment and material on Site. In the event of any questions as to whether an area to be loaded has adequate bearing capacity, the Contractor shall consult with the Engineer prior to the placement of such equipment or material.

E. The Contractor shall promptly repair damages caused to adjacent facilities by demolition operations at no cost to the Owner.

3.03 DEMOLITION, SALVAGE, AND RELOCATION

A. The Contract Documents indicate existing facilities to be demolished, salvaged, and/or relocated. Auxiliary utilities including such services as water, air, chemicals, drainage, lubrication, fluid power, electrical wiring, controls, and instrumentation are not necessarily indicated. The Contractor shall verify the scope of the Work to remove the equipment indicated; coordinate its shutdown, removal, replacement, or relocation; and submit an outage plan in accordance with Section 01 14 00 - Construction Constraints. The removal of existing facilities for demolition, salvage, and relocation shall include the following requirements:

1. Equipment supports, including concrete pads, baseplates, mounting bolts, and support hangers, shall be removed. Damage to the existing structure shall be repaired as indicated.

2. Exposed piping including vents, drains, and valves shall be removed. Where exposed piping penetrates existing floors and walls, the piping, including wall thimbles, shall be removed to a minimum depth of 2-in. Resultant openings in the structure shall be repaired as indicated.

3. Electrical control panels, junction boxes, motor control centers, and local switches and pushbuttons shall be removed.

4. Exposed electrical conduits and associated wiring shall be removed. Resultant openings in structures shall be repaired as indicated.

5. Connections to embedded electrical conduits shall be removed a minimum of 2-in inside the finished surface of the existing structure. Wiring shall be removed and the resulting openings shall be repaired as indicated.

6. Associated instrumentation devices shall be removed.

7. Auxiliary utility support systems shall be removed.

8. The area shall be thoroughly cleaned such that little or no evidence of the previous equipment installation will remain.

9. Asphalt and concrete pavement, curbs, and gutters shall be removed as necessary to perform reconstruction. The limits of removal shall be sawcut. When the required improvements have been constructed, new asphalt and concrete pavement, curbs, and gutters shall be placed to match the original unless otherwise indicated.

10. Footings, foundation walls, below-grade construction and concrete slabs on grade shall be demolished and removed to a depth which will not interfere with new construction, but not less than 36-in below existing ground surface or future ground surface, whichever is lower.

11. Below-grade areas and voids resulting from demolition of structures shall be completely filled. Fill and compaction shall be in accordance with Section 31 30 00 – Earthwork. After fill and compaction, surfaces shall be graded to meet adjacent contours and to provide flow to surface drainage structures, or as indicated.

12. When existing pipe is removed, the Contractor shall plug the resulting open ends whether or not so indicated. Where removed piping is exposed, the remaining piping shall be blind-flanged or fitted with a removable cap or plug.

13. When existing piping is removed from existing structures, the Contractor shall fill resulting openings in the structures and repair any damage such that the finished rehabilitated structure shall appear as a new homogeneous unit with little or no indication of where the new and old materials join. The openings in water-bearing structures shall be filled with non-shrink grout to be watertight and reinforced as required or indicated. In locations where the surface of the grout will be exposed to view, the grout shall be recessed approximately 1/2-in and the recessed area filled with cement mortar grout.

14. Electrical reconstruction shall be conducted by the Contractor in a safe and proper manner to avoid injury from electrical shock to the Owner's and Contractor's personnel. Electrical equipment to be shut off for an extended period of time shall be tagged, locked out, and sealed with a crimped wire and lead seal and made inoperable. At no time shall electrical wiring or connections which are energized or could become energized be accessible to Contractor, Owner, or other personnel without suitable protection or warning signs.

B. The Contractor shall perform a functional test of existing equipment that is relocated and reinstalled to ensure the equipment functions in the manner documented during the initial inspection. The Contractor shall inform the Engineer in writing a minimum of 5 Days prior to the functional testing in order for the Owner and Engineer to witness the test. If, in the opinion of the Engineer, the relocated equipment does not function in a satisfactory manner, the Contractor shall make repairs and modifications necessary to restore the equipment to its original operating condition at no additional cost to the Owner.

3.04 ABANDONMENT

A. Existing facilities to be abandoned shall be prepared as indicated. Where existing buried piping is to be abandoned, the Contractor shall remove the abandoned pipe for a distance of 5 ft from any connecting structures. Openings at the existing structures shall be repaired. The remaining pipe shall be capped at both ends prior to backfill. Buried piping, 12-in diameter or greater shall be completely filled with sand or flowable fill prior to closure of the piping ends.

3.05 REHABILITATION

A. Certain areas of existing structures, piping, conduits, and the like will be affected by Work necessary to complete modifications under this Contract. The Contractor shall be responsible to rehabilitate those areas affected by its construction activities.

B. Where new rectangular openings are to be installed in concrete or concrete masonry walls or floors, the Contractor shall score the edges of each opening (both sides of wall or floor slab) by saw-cutting clean straight lines to a minimum depth of 1-in and then chipping out the concrete. Alternately, the sides of the opening (not the corners) may be formed by saw cutting completely through the slab or wall. Saw cuts deeper than 1-in (or the depth of cover over existing reinforcing steel, whichever is less) shall not be allowed to extend beyond the limits of the opening. Corners shall be made square and true by a combination of core drilling and chipping or grinding. Necessary precautions shall be taken during removal of concrete to prevent debris from falling into or entering adjacent tanks in service or from damaging adjacent equipment or piping. Saw cuts allowed to extend beyond the opening shall be repaired by filling with non-shrink grout. The concrete around any exposed reinforcement steel shall be chipped back and exposed reinforcement steel cut a minimum of 2-in from the finished face of the new opening and be painted with epoxy paint containing a corrosion inhibitor. The inside face of the new opening shall be grouted with a non-shrink grout to fill any voids and cover the exposed aggregate and shall be trowel-finished to provide a plumb and square opening.

C. Where new piping is installed in existing structures, the Contractor shall accurately position core-drilled openings in the concrete as indicated or otherwise required. Openings shall be of sufficient size to permit a final alignment of pipelines and fittings without deflection of any part and to allow adequate space for satisfactory packing where pipe passes through the wall to provide watertightness around openings so formed. The boxes or cores shall be provided with continuous keyways to hold the filling material in place, and they shall have a slight flare to facilitate grouting and the escape of entrained air during grouting. Before placing the non-shrink grout, concrete surfaces shall be sandblasted, thoroughly cleaned of sand and any other foreign matter, and coated with epoxy bonding compound.

D. Pipes, castings, or conduits shall be grouted in place by pouring in grout under a head of at least 4-in.The grout shall be poured or rammed or vibrated into place to fill completely the space between the pipes, castings, or conduits, and the sides of the openings so as to obtain the same watertightness as through the wall itself. The grouted casings shall then be water cured.

E. In locations where the surface of the grout will be exposed to view, the non-shrink grout shall be recessed approximately ½-in and the recessed area filled with cement mortar grout.

F. When new piping is to be connected to existing piping, the existing piping shall be cut square and ends properly prepared for the connection. Any damage to the lining and coating of the existing piping shall be repaired. Dielectric insulating joints shall be installed at interconnections between new and existing piping.

G. Where existing equipment, piping, and supports, electrical panels and devices, conduits, and associated appurtenances are removed, the Contractor shall rehabilitate the affected area such that little or no evidence of the previous installation remains. Openings in concrete floors, walls, and ceilings from piping, conduit, and fastener penetrations shall be filled with non-shrink grout and finished to match the adjacent area. Concrete pads, bases associated with equipment, supports, and appurtenances shall be removed by chipping away concrete and cutting any exposed reinforced steel and anchor bolts a minimum of 2-in below finished grade and be painted with epoxy paint. The area of concrete to be rehabilitated shall be scored by saw cutting clean, straight lines to a minimum depth of 1 ½-in , and concrete within the scored lines removed to a depth of 1 ½-in (or the depth of cover over reinforcing steel, whichever is less). The area within the scored lines shall be patched with non-shrink grout to match the adjacent grade and finish. Abandoned connections to piping and conduits shall be terminated with blind flanges, caps, and plugs suited for the material, type, and service of the pipe or conduit.

H. Existing reinforcement to remain in place shall be protected, cleaned, and extended into new concrete. Existing reinforcement not to be retained shall be cut-off as follows:

1. Where new concrete joins existing concrete at the removal line, reinforcement shall be cut-off flush with the concrete surface at the removal line.

2. Where the concrete surface at the removal line is the finished surface, the reinforcement shall be cut back 2-in below the finished concrete surface, the ends painted with epoxy paint and the remaining holes patched with a cement mortar grout.

I. Where existing handrailing is removed, post embedment's and anchors shall be removed, and post holes shall be filled with non-shrink grout flush to the floor surface. At the point of continuation of existing handrailing, a new post with rail connections matching the existing handrailing system shall be installed. New posts in existing concrete floors shall be installed in core-drilled socket holes and the annular space between the post and hole filled with non-shrink grout.

J. Where reconstruction activities damage the painting and coating of adjacent or nearby facilities, the damaged areas shall be surface prepared and coated in accordance with Section 09 96 00.10 – High-Performance Coatings to match the original painting and coating with a compatible system. Surfaces of equipment items that are to be relocated shall be prepared and be coated in accordance with Section 09 96 00.10 – High-Performance Coatings.

3.06 DISPOSAL

A. Demolition and removal of debris shall minimize interference with roads, streets, walks, and other adjacent occupied or used facilities that shall not be closed or obstructed without permission from the Owner. Alternate routes shall be provided around closed or obstructed traffic ways.

B. Site debris, rubbish, and other materials resulting from reconstruction operations shall be legally removed and disposed of. Structures and equipment to be demolished shall be cleaned prior to demolition and the wash water properly disposed of. No trace of these structures shall remain prior to placing of backfill in the areas from which structures were removed.

C. Refuse, debris, and waste materials resulting from demolition and clearing operations shall not be burned.

3.07 OCCUPANCY AND POLLUTION CONTROL

A. Water sprinkling, temporary enclosures, chutes, and other suitable methods shall be used to limit dust and dirt rising and scattering in the area. The Contractor shall comply with government regulations pertaining to environmental protection.

B. Water shall not be used if it creates hazardous or objectionable conditions such as ice, flooding, or pollution.

3.08 CLEANING

A. During and upon completion of Work, the Contractor shall promptly remove tools and equipment, surplus materials, rubbish, debris, and dust and shall leave areas affected by Work in a clean, approved condition.

B. Adjacent structures shall be cleaned of dust, dirt, and debris caused by reconstruction, as requested by the Engineer or directed by governing authorities, and adjacent areas shall be returned to condition existing prior to start of Work.

END OF SECTION

SECTION 03 01 00 – MAINTENANCE OF CONCRETE

PART 1 -- GENERAL

1.01 SUMMARY

A. Remove, repair, or rehabilitate new and existing concrete members and surfaces as indicated.

B. Provide all materials and equipment necessary to accomplish the Work.

C. Repair damage to concrete and concrete surfaces as directed by the client, as shown within the contract documents, or when concrete damage occurs during the removal of embedded items or from other construction activities within the scope and duration of the contract.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC -referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

C. Reference Specifications

01 33 00	Submittal Procedures
03 11 00	Concrete Forming
03 15 00	Concrete Accessories
03 21 00	Reinforcement Bars
03 30 50	Cast-in-Place Concrete
03 60 00	Grouting

D. Reference Standards

American Concrete Institute (ACI)	
ACI 201.1R-08	Guide for Making a Condition Survey of Concrete in Service
ACI 546R-14	Concrete Repair Guide
ASTM International (ASTM)	
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C666	Standard Test Method for Testing Resistance of Concrete to Freezing and Thawing in Sodium Chloride Solution
ASTM C882 (modified)	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear

NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit Shop Drawings for strengthening required around new openings.

2. Submit detailed drawings showing proposed methods for supporting existing structures, equipment, and piping during demolition and repair activities.

C. Concrete Repair Products and Procedures

1. Submit a comprehensive plan for each repair method indicated within this Section, the plan shall include the following:

a. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each product.

b. Curing products and procedures for each repair method for which curing is recommended by the manufacturer.

1.04 QUALIFICATIONS OF CONCRETE RESTORATION FIRMS

A. The concrete restoration Work shall be performed by an experienced firm customarily engaged in performing similar repair work on cast-in-place concrete structures.

B. The restoration firm shall have completed at least 5 similar projects in the last 5 years.

C. The restoration firm shall be certified by the manufacturer of the repair materials.

1.05 QUALITY ASSURANCE

A. Field Tests of Cement Based Mortars and Grouts

1. The Engineer may take compression test specimens during construction from the first placement of each type of mortar or grout, and at intervals thereafter as selected by the Engineer in order to ensure continued compliance with the indicated requirements.

2. The Contractor shall assist the Engineer in obtaining specimens for testing.

3. The compression tests and fabrication of specimens for repair mortar and non-shrink grout will be performed as specified in ASTM C 109.

4. A set of 5 specimens will be made for testing at 7 days, 28 days, and additional time periods as appropriate.

5. Any material, already placed, which fails to meet the indicated performance requirements is subject to removal and replacement as part of the Work.

6. The cost of laboratory tests on mortar and grout will be paid by the Owner, but the Contractor shall be responsible for the cost of any additional tests and investigation on the Work that does not meet the indicated requirements.

7. The Contractor shall supply all necessary materials for fabricating the test specimens.

B. Repair Concrete: Repair concrete shall be tested as required in Section 03 30 50 – Cast-in-Place Concrete.

C. Epoxy Grout: Epoxy grout shall be tested as required in Section 03 60 00 – Grouting.

D. Construction Tolerances: Construction tolerances shall comply with the requirements of Section 03 30 50 – Cast-in-Place Concrete, except as otherwise indicated.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All products and materials in contact with potable water shall be certified as being in conformance with NSF/ANSI 61.

2.02 REPAIR MORTAR

A. Provide repair mortar as a pre-packaged, 2-component, polymer-modified, cementious, non-sag mortar, specifically formulated for the repair of surface defects.

B. Provide the mortar with a penetrating corrosion inhibitor.

C. Repair mortar shall have the following properties:

Physical Property	**Value**	**ASTM Standard**
Compressive Strength (min.)		C-109
at 7 days	6000 psi	
at 28 days	7000 psi	
Bond Strength (min.		C-882 (modified)
at 28 days	2200 psi	
Freeze/Thaw resistance (min.)		C-666
300 cycles	98 percent	

D. Provide a minimum repair thickness of ¼-in, unless otherwise indicated.

E. Repair Mortar shall be SikaTop 123 Plus for vertical and overhead surfaces and SikaTop 122 Plus for horizontal surfaces, by Sika Corporation, or equal.

2.03 NON-SHRINK GROUT

A. Provide non-shrink grout conforming to the requirements of Section 03 60 00 – Grouting.

2.04 CONCRETE MATERIALS

A. Cement

1. Use Type II Portland cement unless otherwise indicated.

2. Where repairs are to be made on wall surfaces open to view and above normal water surface elevations, blend white Portland cement as needed in order to match the color of the adjacent existing concrete surface.

B. Structural Repair Grout

1. Where required, provide structural repair grout meeting the requirements of a Congested Section Concrete Mix design per Section 03 30 50 – Cast-in-Place Concrete.

2. As an alternate to ready mix concrete, the contractor may use Five Star Structural Concrete ES-60 by Five Star Products Inc, or equal, and extended 60% by weight with 3/8-in, non-reactive, washed aggregate per the manufacturer's requirements.

3. Provide a minimum repair thickness of 3-in.

C. Miscellaneous Materials**:** For concrete construction materials not covered specifically in this Section, conform to the requirements of Section 03 30 50 – Cast-in-Place Concrete.

2.05 AGGREGATE

A. Obtain the written permission of the manufacturer and Engineer before using aggregate to extend repair mortar and grout products.

B. If allowed and unless otherwise indicated, provide aggregate consisting of 3/8-in, non-reactive, washed gravel or crushed stone as required in Section 03 30 50 – Cast-in-Place Concrete.

2.06 BONDING AGENT AND ANTI-CORROSION COATING

A. Provide a bonding agent that is a solvent-free, moisture-tolerant, epoxy-modified, cementitious product, specifically formulated as a bonding agent and anti-corrosion coating.

B. Bonding Agent shall be Armatec 110 EpoCem, by Sika Corporation, or equal.

2.07 EPOXY GROUT

A. Provide an epoxy grout conforming to the requirements of Section 03 60 00 – Grouting.

2.08 EPOXY RESIN

A. Use epoxy resin for structural crack repair.

B. For crack injection, provide a 2-component, moisture-tolerant, low-viscosity, high-strength epoxy resin adhesive that is specially formulated for that usage.

C. Provide a minimum bond strength (tensile adhesion strength) of 2900 psi when tested per ASTM C 882 at 14 days, moist cured.

D. Epoxy Resin shall be Sikadur 35, Hi-Mod LV, by Sika Corporation, KEMKO 068 LoVis IR, by ChemCo Systems, Inc., or equal.

2.09 PROTECTIVE COATING

A. Waterproofing

1. Provide a 2-component, polymer-modified, cementitious waterproofing and protective slurry mortar for concrete.

2. Apply the material in 2 coats, with a coverage of 40 sq ft/gal/coat.

3. Waterproofing shall be Sika Top Seal 107, by Sika Corporation, or equal.

2.10 FORMWORK

A. Where needed, provide formwork that meets the requirements of Section 03 11 00 – Concrete Forming.

2.11 REINFORCEMENT STEEL

A. Where required, provide reinforcing steel that meets the requirements of Section 03 21 00 – Reinforcement Bars.

2.12 POLYURETHANE SEALANT

A. Use polyurethane sealant for expansion joint repair.

B. Provide a 2-part polyurethane, gun-grade sealant.

C. Polyurethane Sealant shall be Sikaflex – 2C, by Sika Corporation, or equal.

2.13 POLYURETHANE CHEMICAL GROUT

A. Use polyurethane chemical grout for non-structural crack repair.

B. Polyurethane Chemical Grout shall be SikaFix HH, by Sika Corporation, De Neef Flex LV PURe, by GCP Applied Technologies, De Neef Flex SLV PURe, by GCP Applied Technologies, or equal.

2.14 EXPANSION JOINTS

A. Provide an expansion joint system for repair of the existing expansion joints, consisting of a Hypalon sealing strip and an epoxy adhesive in order to provide a watertight seal.

B. Expansion Joint System shall be Sikadur Combiflex, by Sika Corporation, or equal.

2.15 HYDROPHILIC WATERSTOP

A. Provide hydrophilic waterstop of the type which expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

B. Provide hydrophilic waterstop that is bentonite-free and manufactured from chloroprene rubber and modified chloroprene rubber with hydrophilic properties.

C. Hydrophilic Waterstop shall be Hydrotite RSS-040 P, by Sika Corporation, KM 4mm String, by Adeka Ultra Seal, or equal.

2.16 HIGH STRENGTH EPOXY GEL

A. High-Strength Epoxy Gel for crack surface sealing shall be Denepox Rapidgel, by GCP Applied Technologies, or equal.

2.17 EPOXY BONDING ADHESIVE

A. Epoxy Bonding Adhesive shall be Sikadur 31, by Sika Corp, Tyfo S by Tyfo/Aegion, or equal.

PART 3 -- EXECUTION

3.01 GENERAL

A. Repairs

1. Repair techniques will be reviewed during the pre-construction meeting between the Contractor, Engineer, and Owner.

2. The Contractor shall be familiar with the cause of deteriorated concrete and shall choose the right equipment, repair materials and techniques to be used for each particular repair.

3. Choose repair materials to match the adjacent concrete surface in color and texture.

4. Apply repair materials in strict accordance with the manufacturer's printed instructions, including temperature and moisture requirements throughout application and curing.

5. Protect adjacent portions of the structure, including all valves, pipes, mechanical equipment, and filter media from debris generated by repair activities.

6. For portions of the structure that are not identified to be repaired, maintain in their original condition.

B. Structural Stability

1. Use caution not to weaken the structural capacity of a beam, column, wall, slab, walkway, or other concrete member during concrete removal.

2. For severely deteriorated concrete members, consult with the Engineer before removing a major portion of any structural member.

3. Shoring may be required in order to support the structure and to protect workers.

C. Provide off-site disposal of debris generated as a result of repair procedures.

D. Provide concrete construction procedures not specifically addressed in this Section in accordance with the requirements of Section 03 30 50 – Cast-in-Place Concrete.

3.02 REPAIR SEQUENCING

A. Unless otherwise indicated, perform concrete repairs in the following sequence, with no activity in an area being started until previous activities in that area have been completed, including curing, cleanup, and the like:

1. removal of equipment, miscellaneous metals, and other surface features that would interfere with the repair;

2. removal of concrete sections which require complete replacement;

3. surface preparation hydroblasting over the entire area to be repaired;

4. embedded metal repair;

5. crack repair;

6. filter trough to wall connection repair;

7. spalled and delaminated concrete repair;

8. scaled concrete;

9. pop-out repair, and repair of other surface damage, deterioration, or defects;

10. patching of holes in concrete;

11. replacement of concrete sections which require complete replacement;

12. new construction;

13. application of protective coatings;

14. expansion joint repair; and,

15. installation of traffic topping.

B. For areas which require combinations of spalled and delaminated concrete repair, scaled concrete, and pop-out repair, perform these repairs at the same time.

C. Limit the size of the repair area in order to permit the repairs to be performed together, without sacrificing the quality of the individual repairs.

3.03 EMBEDDED METAL REPAIR

A. Unless otherwise indicated, repair anchor bolts and other embedded metal, except rebar, that are exposed at the concrete surface and are showing signs of corrosion, as follows:

1. Cut off or otherwise remove corroded metal fastened at the surface;

2. Trim back embedded metals to a depth of at least 2-in beyond the surface of sound concrete;

3. Chip away unsound concrete around the embedded metal.

4. Apply epoxy grout to the repair area until level with the surface of the surrounding sound concrete.

B. Unless otherwise indicated, repair embedded rebar that is exposed at the concrete surface following the procedures outlined in the appropriate concrete repair subsection, below.

3.04 CRACK REPAIR

A. Structural Cracks - Structural Cracks are defined as follows:

1. All cracks where reinforcing steel is passing across the crack, including erratic cracks, and cracks at construction joints.

2. Repair structural cracks with epoxy resin.

B. Non Structural Cracks - Non Structural Cracks are defined as follows:

1. Cracks occurring at flexible joints, contraction joints or expansion joints.

2. Repair non-structural cracks with polyurethane chemical grout.

C. Efflorescence

1. Prior to the crack repair, clean efflorescence from the cracks and the surrounding area.

2. Clean the efflorescence by light hydro-blasting or scrubbing.

D. Pressure Injection: Pressure Injection to be performed prior to leak testing and roof membrane installation.

1. General

a. The indicated repair materials have been selected to minimize the loss of material during the injection process. The areas selected for crack repair are to be identified by the Contractor, Engineer or Construction Manager and be determined prior to leak tests and roof membrane installation. The injection of cracks may also be required as a result of the leak test.

b. In order to avoid excessive loss of injected material at the lower exposed portions of the cracks, space the injection ports a distance no greater than the thickness of the wall being repaired.

2. Structural cracks – Open through thickness cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. All 3 ft long or greater through thickness cracks, wider than 15 mils, in the walls are to be injected unless they do not accept grout. All 2 ft long or greater through thickness cracks, wider than 10 mils, in the foundation/floor slabs and roof are to be injected unless they do not accept grout. Perform structural crack repairs by pressure injection in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

    a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

    b. Remove any contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. For potable water applications, any solvents must be fully flushed from the joint unless NSF/ANSI Standard 61 approved.

    c. Install the injection ports in accordance with the manufacturer's directions.

    d. Sealing

        1) Seal the surface in order to keep the pressure injecting materials from leaking out before it has set or gelled.

        2) Seal a surface by brushing an epoxy over the surface of the crack and allowing it to harden, or use high injection pressures to cut-out the cracks in a 'V' shape, fill with an epoxy, and strike off flush with the surface.

        3) Surface patching or sealant shall be performed where needed to provide for complete penetration of the injected polyurethane grout and to prevent wastage. Seal surface of crack with fast setting hydraulic cement or high strength epoxy gel. The floor surface along the cracks shall be cleaned and all wasted grout and surface seal material shall be completely removed from the concrete surface following completion of the repair work

    e. Inject the repair materials, with consideration of the following items:

        1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

        2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, then cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled.

        3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

        4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end, using low-viscosity repair material.

    f. Cleanup

        1) Remove the surface seal by grinding or other appropriate means.

2) Coat fittings and holes at injection ports with an epoxy patching compound.

3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3. Non-structural cracks – Open through thickness cracks are to be repaired to deliver a water tight hydraulic structure passing the specified leakage test. All 3 ft long or greater through thickness cracks, wider than 15 mils, in the walls are to be injected unless they do not accept grout. All 2 ft long through thickness cracks, wider than 10 mils, in the foundation/floor slabs and roof are to be injected unless they do not accept grout. Perform non-structural crack repairs in accordance with the manufacturer's directions, and in accordance with the following basic procedure:

   a. Remove unsound and foreign materials from the crack in a manner that does not trap debris in the crack and prevent the flow of repair materials.

   b. Remove contamination by flushing with water or solvent, allowing adequate time for air-drying or blow out the solvent with compressed air. Any solvents must be fully flushed from the joint unless NSF/ANSI Standard 61 approved.

   c. Install the injection ports in accordance with the manufacturer's directions.

   d. Moisture

      1) For non-structural cracks, moisture must be present for the chemical grout to react.

      2) Prior to injecting the repair materials, inject the crack with a small amount of water in order to completely moisten the crack.

   e. Inject the repair materials, with consideration of the following items:

      1) Carefully select the pressure of the hydraulic pump or other device, because too much pressure can extend the existing cracks and cause more damage.

      2) For vertical cracks, start by pumping material into the entry port at the lowest elevation until the material level reaches the entry port above, cap the lower injection port and repeat the process at successively higher ports until the crack has been completely filled, and then, starting again at the lowest port, re-inject into all ports in order to ensure that all voids are properly sealed off.

      3) For horizontal cracks, start at one end of the crack and work to the other end, filling the crack until the pressure can be maintained.

      4) For very fine cracks, start the injection of repair material at the widest end and proceed toward the thinner end.

   f. Cleanup

      1) Remove excess surface material by grinding or other appropriate means.

      2) Coat fittings and holes at injection ports with an epoxy patching compound.

3) If crack repairs are part of repair for surface defects, painting with epoxy is not necessary and surface preparation may be started after crack repairs have been completed.

3.05 SPALLED AND DELAMINATED CONCRETE REPAIR

A. Repair spalls and delaminated concrete using repair mortar.

B. Surface Preparation

1. Remove all delaminated concrete and all unsound concrete beyond the spalled or delaminated area.

2. Boundaries

a. Determine the boundaries of the patch by sawcuts to a depth of at least ¼-in up to 1-in deep.

b. Refer to the Structural Drawings for sawcut locations.

c. Where the sawcut locations are not shown on the Drawings, the boundary layouts shall be designed to reduce boundary edge length.

d. Avoid excessive or complex edge conditions.

3. Sawcuts

a. Perform sawcuts perpendicular to the surface or slightly undercut.

b. Construct sawcuts in maximum ¼-in increments.

c. After each incremental cut, inspect the cut surface in order to ensure that the existing reinforcement has not been cut.

d. If at any depth the reinforcement becomes exposed, terminate the sawcut and notify the Engineer.

4. Chip away concrete within the repair area to a depth sufficient to expose sound concrete over the entire repair area, or to a minimum depth required by repair mortar, whichever is greater.

5. Base the selection of partial depth concrete removal equipment on the size of repair area, depth of concrete to be removed, and the location of the deteriorated concrete such as wall, slab-on-grade, underside or top of elevated slab.

6. Removal

a. The maximum allowable pneumatic chipping hammer shall be a 30 lbs class hammer.

b. Hydroblast removal shall use a maximum pressure of 40,000 psi.

c. Sand blasting is not permitted.

d. Hydroblast concrete removal is recommended for large area of surface defects.

e. Remove water blasting debris daily in order to prevent it from setting up.

f. If a chipping hammer is used, ensure that the existing structure and reinforcement are not damaged during the concrete removal operations.

g. Remove protrusions, such as mortar spatter or fins, by grinding or by striking with a hammer or other tool.

7. Reinforcement

a. Remove concrete from around reinforcement when the rebar is rusted, more than half the rebar perimeter is already exposed, the concrete bond around the rebar is broken, or if the concrete is unsound or honey-combed.

b. Remove concrete in order to provide a clear space of minimum 1-in on all sides of the reinforcement, such that the rebar can be cleaned and the repair material will completely surround the rebar.

c. Clean exposed reinforcement by water blasting or wire brushing.

d. After fully exposing and cleaning the reinforcement, check for steel deterioration, and if the cross-sectional area of the steel has been reduced by more than 10 percent, whether by deterioration, surface preparation, or a combination of both, provide additional reinforcement.

e. Consult with the Engineer before adding or replacing rebar.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning the reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Repair Mortar

a. Apply repair mortar in accordance with the manufacturer's recommendations.

b. The thickness of each lift of repair mortar shall be in accordance with the manufacturer's recommendations, with the minimum thickness being not less than ¼-in.

7. Fully consolidate the repair mortar, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Float-finish the repaired surface using wood or sponge floats.

10. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

11. For repaired surfaces to receive a protective coating, brush-finish the surface in order to produce a roughened substrate for the coating.

12. Minimum and maximum ambient and surface temperatures shall be as recommended by repair material manufacturer.

D. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

c. Ensure that edges are continuously held in place; and,

d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 deg F for at least 3 days after placement.

3.06 SCALED CONCRETE REPAIR

A. Repair scaling and pop-outs using repair mortar.

B. Surface Preparation

1. Prior to repair, prepare the surface in accordance with the repair mortar manufacturer's recommendations with the following minimum requirement.

2. Remove unsound concrete from surfaces by high-pressure water blasting, using a minimum pressure of 10,000 psi and maximum pressure of 40,000 psi.

3. Clean exposed reinforcement by water blasting or wire brushing.

C. Repairing Surface Defects

1. Clean the concrete surface after removing unsound concrete, repairing cracks, and cleaning reinforcement.

2. Ensure that the concrete surface and reinforcement are free of form-release agents, curing compounds, surface hardeners, oils, grease, food, chemicals, and other contaminants.

3. Remove dust, including new dust generated by surface preparation or scarifying.

4. Prior to application of the bonding agent, apply anti-corrosion coating to exposed rebar in accordance with the manufacturer's recommendations, allow the coating to dry, reapply the coating, and allow to dry again.

5. Prior to applying the repair mortar, apply bonding agent in accordance with the manufacturer's recommendations.

6. Apply repair mortar in accordance with the manufacturer's recommendations, using a minimum repair material thickness of ¼-in.

7. Fully consolidate the repair material, working the material into the substrate to completely fill all pores and voids in the area to be filled.

8. Bring the repair surface into alignment with the adjacent existing surfaces in order to provide a uniform, even surface.

9. Float-finish the repaired surface using wood or sponge floats.

10. Match the repair surface to adjacent existing surfaces in texture by applying necessary coatings and surface treatments.

D. Provide strip joint in newly placed mortar at the location of repaired cracks.

E. Curing

1. Curing of repair mortar to receive waterproofing shall be as follows:

   a. Keep the mortar continuously wet by the application of water for a minimum period of at least 7 consecutive days, beginning immediately after the mortar has reached final set;

   b. Weight the curing blankets or otherwise held them in place in order to prevent being dislodged by wind or other causes, and to be substantially in contact with the concrete surface;

   c. Ensure that edges are continuously held in place; and,

   d. Keep the curing blankets and concrete continuously wet by the use of sprinklers or other means, both during and after normal working hours.

2. If the repair mortar is not to receive waterproofing, provide curing in accordance with the manufacturer's recommendations except that the minimum cure period shall be 7 days.

3. During cold weather, maintain the repair material temperature above 50 deg F for at least 3 days after placement.

3.07 POP-OUT REPAIR, AND REPAIR OF OTHER SURFACE DAMAGE, DETERIORATION, OR DEFECTS

A. Repair pop-outs and other surface damage, deterioration, and defects which are ¼-in deep or shallower, using the procedures described under "SCALED CONCRETE REPAIR," above.

B. Repair other pop-outs and surface damage, deterioration, and defects using the procedures described under "SPALLED AND DELAMINATED CONCRETE REPAIR," above.

3.08 REPLACEMENT OF CONCRETE SECTIONS WHICH REQUIRE COMPLETE REPLACEMENT

A. Refer to the Structural Drawings for locations where the level of concrete deterioration is such that complete removal and replacement of the deteriorated section is required.

B. At these locations, remove the deteriorated concrete in accordance with the details on the Structural Drawings and the requirements of this Section.

C. Limits

1. The limits of concrete removal shall be as indicated on the Structural Drawings.

2. If no limits of removal are indicated, determine the limits in accordance with the procedures described under “Boundaries – Spalled and Delaminated Concrete Repair.”

D. Provide sawcuts in accordance with the procedures described under “Sawcuts – Spalled and Deliminated Concrete Repair.”

E. After removal of the concrete, prepare the area and provide repair concrete in accordance with the details on the Structural Drawings and the requirements of this Section.

F. Unless otherwise indicated, match the finished cross-section of the repaired concrete to the cross-section of the adjacent undamaged concrete.

3.09 PATCHING OF HOLES IN CONCRETE

A. General

1. For the purposes of this Section, holes are defined as penetrations completely through the concrete member and with interior surfaces approximately perpendicular to the surface of the existing member.

2. Interior surface areas which are inclined and do not meet this criteria shall be chipped as needed to meet this requirement.

3. The perimeter of holes at the surface shall form a regular shape composed of curved or straight line segments.

4. Provide the minimum depth of placement for the material used; score the existing concrete by sawcutting, and chip as needed to meet this requirement.

5. Roughen the interior surface of holes less than 12-in in diameter to a minimum of 0.125-in amplitude and roughen larger holes to a minimum of 0.25-in amplitude.

6. At holes, coat the existing surface to be repaired with a bonding agent.

B. Patching Small Holes: For holes which are less than 12-in in their least dimension and extend completely through concrete members, fill with non-shrink grout.

C. Patching Large Holes

1. Fill holes which are larger than 12-in in their least dimension with structural repair grout.

2. Provide large holes which are normally in contact with water or soil with hydrophilic waterstop placed in a groove.

3. Alternatively, bond the hydrophilic waterstop to the surface using an epoxy grout which completely fills all voids and irregularities beneath the waterstop material.

4. Install the waterstop in accordance with the requirements of Section 03 15 00 – Concrete Accessories.

5. Provide reinforcing steel in layers matching existing reinforcement location, size, spacing and cover requirements unless directed otherwise by the Engineer.

6. In locations where NSF/ANSI Standard 61 approval is required by the authority having jurisdiction, use one of the following procedures:

a. Provide Product Data showing the proposed structural repair grout is NSF/ANSI Standard 61 approved.

b. Complete the repair with structural repair grout. Coat all surfaces required to have NSF/ANSI Standard 61 approval completely with epoxy bonding adhesive.

c. Place the structural repair grout to within 1.5-in of the finished surface of the repair. Complete the remainder of the repair with SikaTop Plus per the repair mortar requirements.

3.10 PATCHING OF LINED HOLES

A. General

1. This Work applies to those openings which have embedded material over all or a portion of their inside edge.

2. The requirements for repairing holes in concrete, as indicated above, apply as modified herein.

3. The Engineer will determine whether the embedded material is allowed to remain.

B. Where embedded material is allowed to remain, trim it back a minimum of 2-in from the concrete surface.

C. Roughen or abrade the embedded material in order to promote good bonding to the repair material.

D. Remove substances that interfere with good bonding.

E. Completely remove embedded items that are not securely and permanently anchored into the concrete.

F. Completely remove embedded items which are larger than 12-in in their least dimension, unless they are composed of a metal to which reinforcing steel can be welded; where reinforcement is required, weld it to the embedded metal.

G. The following requirements shall apply to concrete members which are in contact with water or soil:

1. Using epoxy grout, fill lined openings which are less than 4-in in their least dimension;

2. Using an epoxy bonding agent, coat lined openings which are greater than 4-in but less than 12-in in their least dimension, prior to being filled with non-shrink grout.

3. Using an epoxy bonding agent, coat lined openings which are greater than 12-in in their least dimension, and provide a hydrophilic waterstop bonded to the interior of the opening with epoxy adhesive, prior to being filled with approved repair material.

3.11 APPLICATION OF PROTECTIVE COATINGS

A. Waterproofing

1. Apply waterproofing in accordance with the manufacturer’s printed instructions.

2. Do not begin waterproofing Work until repairs and new construction in the affected area have been completed and adequately cured.

3.12 EXPANSION JOINT REPAIR

A. Repair deteriorated expansion joints as follows:

1. Completely remove existing sealant;

2. Remove defective backer materials in the joint;

3. Sand-blast the joint and prepare the surface in accordance with the sealant manufacturer’s instructions;

4. Prepare the wall surface on each side of the joint in accordance with the expansion joint manufacturer’s instructions;

5. Ensure that the prepared surface is clean, sound, and bare concrete;

6. Place backer material in the joint;

7. Apply a primer recommended by the sealant manufacturer;
8. Fill the joint with polyurethane sealant;
9. Allow a minimum of 3 days curing prior to installing the expansion joint; and,
10. Install the expansion joint in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 03 11 00 – CONCRETE FORMING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

C. Reference Specifications

01 33 00	Submittal Procedures
03 30 50	Cast-in-Place-Concrete

D. Reference Standards

American Concrete Institute (ACI)	
ACI 117	Standard Tolerances for Concrete Construction and Materials.
National Institute of Standards and Technology (NIST)	
Voluntary Product Standard PS 20	American Softwood Lumber Standard.
Voluntary Product Standard PS 1	Structural Plywood
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Manufacturer's information demonstrating compliance with requirements for the following:

1. Form ties and related accessories, including taper tie plugs, if taper ties are used.

2. Form gaskets.

3. Form release agent, including NSF/ANSI 61 certification if not using mineral oil.

4. Manufacturer's design information on formwork, form materials, and locations for use.

1.04 QUALITY ASSURANCE

A. Tolerances: The variation from required lines or grade shall not exceed 1/4-in in 10 feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. Other tolerances shall be within the tolerances of ACI 117.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Except as otherwise expressly accepted by the Engineer, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Walls	Steel, fiberglass, or plywood panel
Columns	Steel, plywood, or fiberglass
Roof and floor	Plywood
All other Work	Steel panels, fiberglass, plywood or tongue and groove lumber

B. Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF 61.

C. Water-based form release agent shall be Clean Strip J1EF by Dayton Superior, or equal.

2.02 FORM AND FALSEWORK MATERIALS

A. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with Voluntary Product Standard PS 20.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of Voluntary Product Standard PS 1 – Exterior Plywood for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall conform to the requirements of Voluntary Product Standard PS 1 – Exterior Plywood for Concrete Forms, Class I, Medium Density Overlaid (MDO) Grade.

4. Steel leave in place forms shall not be used.

B. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-in chamfers or be tooled to 1/2-in radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

C. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf minimum. The minimum design load for combined dead and live loads shall be 100 psf.

2.03 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1 ½-in; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be ST-4 Hex Head Snaptie by MeadowBurke, A3 Snap-Ties by Dayton Superior, or equal.

B. Removable taper ties may be used when approved by the Engineer. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be inserted in the hole left by the removal of the taper tie. Use HD-9 Taper-Tie by MeadowBurke, D9 Taper-Tie by Dayton Superior, or equal.

PART 3 -- EXECUTION

3.01 GENERAL

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by Contractor's personnel and by the Engineer and shall be in sufficient number and properly installed. During concrete placement, the Contractor shall continually monitor plumb and string line form positions and immediately correct deficiencies.

B. Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.

C. Forms shall be removed unless approved otherwise by the Engineer.

3.02 FORM DESIGN

A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Plywood, 5/8-in and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1- to 1 ½-in diameter polyethylene rod held in position to the underside of the wall form. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the Engineer. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 50 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the Engineer.

3.03 CONSTRUCTION

A. Vertical Surfaces: Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-in of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties

1. Embedded Ties: Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-in back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-in of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

3.04 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces Exposed concrete surfaces are defined as surfaces which are permanently exposed to view In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the Engineer.

3.05 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this Work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. In the case of roof slabs and above-ground floor slabs, forms shall remain in place until test cylinders for the roof concrete attain a minimum compressive strength of 75 percent of the 28 day strength in Section 03 30 50 - Cast-in-Place Concrete. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 day strength and has been in place for a minimum of 7 days. The time required to establish said strength shall be as determined by the Engineer who will make several test cylinders for this purpose from concrete used in the first group of roof panels placed. If the time so determined is more than the 7 day minimum, then that time shall be used as the minimum length of time. Forms for vertical walls of waterholding structures shall remain in place at least 36 hours after the concrete has been placed. Forms for parts of the Work not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

3.06 MAINTENANCE OF FORMS

A. Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned. The form surfaces shall be treated with a nonstaining mineral oil or other lubricant acceptable to the Engineer. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the Contractor shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.

3.07 FALSEWORK

A. The Contractor shall be responsible for the design, engineering, construction, maintenance, and safety of falsework, including staging, walkways, forms, ladders, and similar appurtenances, which shall equal or exceed the applicable requirements of the provisions of the OSHA Safety and Health Standards for Construction, and the requirements herein.

B. Falsework shall be designed and constructed to provide the necessary rigidity and to support the loads. Falsework for the support of a superstructure shall be designed to support the loads that would be imposed if the entire superstructure were placed at one time.

C. Falsework shall be placed upon a solid footing, safe against undermining, and be protected from softening. When the falsework is supported on timber piles, the maximum calculated pile loading shall not exceed 20 tons. When falsework is supported on any portion of the structure which is already constructed, the load imposed by the falsework shall be spread, distributed, and braced in such a way as to avoid any possibility of damage to the structure.

END OF SECTION

SECTION 03 15 00 – CONCRETE ACCESSORIES

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.

B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the Engineer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
03 30 50	Cast-in-Place Concrete
07 92 13	Elastomeric Joint Sealants

C. Reference Standards

1. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of award of this contract.

American Concrete Institute (ACI)	
ACI 330.1	Specification for Unreinforced Concrete Parking Lots and Site Paving
ASTM International (ASTM)	
ASTM A775	Standard Specification for Epoxy Coated Steel Reinforcing Bars
ASTM C920	Standard Specification for Elastomeric Joint Sealants
ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
ASTM D624	Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D747	Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam

ASTM D1056	Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber
ASTM D1752	Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2000	Standard Classification System for Rubber Products in Automotive Applications
ASTM D2240	Standard Test Method for Rubber Property – Durometer Hardness
ASTM D2241	Standard Specification for PolyVinylchloride (PVC) Pressure-Rated Pipe (SDR Series)
National Bureau of Standards	
Federal Specification TT-S-0227E	Sealing Compound: Elastomeric Type, Multi-Component (For Caulking, Sealing and Glazing in Buildings and Other Structures)
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects
U.S. Army Corps of Engineers	
Specification CRD-C572	Specification for PolyVinylchloride Waterstops

1.03 TYPES OF JOINTS

A. Construction Joints

1. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.

2. Construction joints in water-bearing members shall be provided with a waterstop.

3. Construction joints shall have sealant grooves of the shape indicated, except where indicated otherwise.

B. Contraction Joints

1. Contraction joints are similar to construction joints except that the fresh concrete shall not bond to the hardened surface of the earlier pour.

2. The slab reinforcement shall be stopped 4 inches from the joint; which is provided with a sleeve-type dowel, in order to allow shrinkage of the concrete of the later pour.

3. Waterstop and/or sealant groove shall be provided where indicated.

4. At full contraction joints, all reinforcement is terminated clear of the joint. At partial contraction joints, a portion of the reinforcement is terminated clear of the joint, with the remainder being continuous through the joint.

C. Expansion Joints

1. In order to allow the concrete to expand freely, a space shall be provided between the 2 pours, and the joint shall be formed as indicated.

2. The space shall be obtained by placing a joint filler material against the earlier pour to act as a form for the later pour.

3. Unless otherwise indicated, expansion joints in water bearing members shall be provided with a center-bulb type waterstop.

4. Provide premolded expansion joint filler material with the edge at the indicated distance below or back from the finished concrete surface.

5. Provide a slightly tapered, dressed and oiled wooden strip secured to or placed at the edge of the expansion joint during concrete placement and remove the strip later to form a space for the sealing material.

6. The space so formed shall be filled with a joint sealant material as indicated below. In order to keep the 2 wall or slab elements in line, the joint shall also be provided with a sleeve-type dowel as indicated.

D. Control Joints

1. The function of the control joint is to provide a weaker plane in the concrete where shrinkage cracks would likely occur.

2. Formed Groove

a. A groove, of the shape and dimensions indicated, shall be formed or saw-cut in the concrete and the groove shall then be filled with a joint sealant material.

b. The formed groove shall be placed in the first of the two sections cast at the control joint, in order to assure that the sealant bonds to the second section across the joint and not to the cement paste from the first pour.

1.04 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Furnish placement drawings showing the location and types of joints for each structure.

2. Test Reports

a. Furnish certified test reports from the sealant manufacturer on the actual batch of material supplied, demonstrating compliance with the indicated requirements.

b. Furnish the test reports before using the sealant on the Project.

3. Welding Certification

a. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.

b. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the Engineer, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

4. Joint Sealant Installation Certification

a. Furnish copies of the joint sealant installation certification by manufacturer or authorized agent of the manufacturer.

b. Every person who is to be involved with joint sealant installation shall be required to have individual certification on file with the Engineer, stating that the named individual is certified and trained to install joint sealant in accordance with the manufacturer's recommendations and specifications.

5. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:

a. bearing pad

b. neoprene sponge

c. preformed joint filler

d. backing rod

e. waterstop

f. slip dowels

g. PVC tubing

C. Samples

1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.

2. Such samples shall be extruded or molded sections of each size or shape to be installed.

3. The balance of the material to be used shall not be produced until after the Engineer has reviewed the qualification samples.

D. Certificates

1. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.

2. Supplier certificates will not be accepted.

1.05 QUALITY ASSURANCE

A. Waterstop Inspection

1. Field joints in waterstops shall be subject to inspection. No such Work shall be scheduled or started without having made prior arrangements with the Engineer for the required inspections.

2. Provide not less than 24 hours notice for the scheduling of such inspections.

3. Field joints in PVC waterstops shall be subject to inspection for misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects that would reduce the potential resistance of the material to water pressure at any point.

4. Defective field joints shall be replaced with material that passes inspection, and faulty material shall be removed from the Site and destroyed.

B. The following waterstop defects represent a partial list of defects which shall be grounds for rejection:

1. Offsets at joints greater than 1/16 inch or 15 percent of material thickness at any point, whichever is less

2. Exterior cracking at the joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness at any point, whichever is less

3. Any combination of offset or exterior cracking that will result in a net reduction in the cross-section of the waterstop in excess of 1/16 inch or 15 percent of material thickness at any point, whichever is less

4. Misalignment of the joint which results in misalignment of the waterstop in excess of 1/2 inch in 10 feet

5. Porosity in the welded joint as evidenced by visual inspection

6. Bubbles or inadequate bonding which can be detected with a penknife test. (If, while prodding the entire joint with the point of a penknife, the knife breaks through the outer portion of the weld into a bubble, the joint shall be considered defective.)

7. Visible signs of separation when the cooled splice is bent by hand at any sharp angle

8. Evidence of burned material

C. Waterstop Samples

1. Prior to use of the waterstop material in the field, a sample of a prefabricated (shop made fitting) mitered cross and a tee constructed of each size or shape of material to be used shall be submitted.

2. Samples shall be prefabricated (shop made fitting) so that the material and workmanship represent the fittings to be provided.

3. In addition, field samples of prefabricated fittings (crosses, tees, and the like) will be selected at random by the Engineer for testing by a laboratory at the Owner's expense.

4. When tested, the tensile strength across the joints shall be at least 1120 psi for PVC waterstops.

D. Construction Joint Sealant

1. The Contractor shall prepare adhesion and cohesion test specimens at intervals of 5 Days while sealants are being installed.

2. The sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:

a. Sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch).

b. Spacing between the blocks shall be one inch.

c. Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to set and hold sealant cross-sections of 1/2-inch by 2-inch with a width of one inch.

d. The sealant shall be cast and cured in accordance with the manufacturer's recommendations, except that the curing period shall be not less than 24 hours.

e. Following the curing period, the gap between the blocks shall be widened to 1-1/2 inches, and spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

1.06 SPECIAL CORRECTION OF DEFECTS REQUIREMENT

A. The Contractor shall furnish a 5-year written warranty of the entire sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that the Contractor agrees to repair or replace, to the satisfaction of the Owner, any defective areas which become evident within the 5-year period.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Joint materials in contact with potable water shall be certified as being in compliance with NSF/ANSI 61.

2.02 WATERSTOPS

A. PVC Waterstops

1. PVC waterstops shall be Earthshield, by JP Specialties, Greenstreak, by Sika, Vinylex PVC Waterstop, by Vinylex, or equal.

2. Waterstops shall be extruded from an elastomeric polyvinyl chloride compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the indicated requirements of this Section.

3. No reclaimed or scrap material shall be used.

4. The Contractor shall obtain from the waterstop manufacturer and shall furnish to the Engineer for review, current test reports and a written certification of the manufacturer that the material to be shipped to the Site meets the physical requirements as outlined in CRD-C572, and those indicated.

5. Flatstrip and Center-Bulb Waterstops

    a. Flatstrip and center-bulb waterstops shall be manufactured such that at no place shall the thickness of waterstops, including the center bulb type, be less than 3/8 inch.

    b. The waterstop shall be provided with hog rings or eyelets installed at 12 inches on centers along the waterstop.

    c. Shapes shall be as indicated, or as acceptable to the Engineer.

6. Multi-Rib Waterstops

    a. Multi-rib waterstops shall be as indicated or as acceptable to the Engineer.

    b. Prefabricated joint fittings shall be used at intersections of the ribbed-type waterstops.

7. Retrofit Waterstops

    a. Retrofit waterstops and batten bars shall be as indicated or as acceptable to the Engineer.

    b. The waterstop shall be supplied as a complete system including waterstop, SS batten bar, SS anchor bolts, and epoxy gel.

8. When tested in accordance with the indicated test standards, the waterstop material shall meet or exceed the following requirements:

Physical Property, Sheet Material	**Value**	**ASTM Std**
Tensile Strength-min, psi	2000	D 638, Type IV
Ultimate Elongation-min, percent	300	D 638, Type IV
Low Temp Brittleness, max degrees F	-35	D 746
Stiffness in Flexure, min, psi	600	D 747
Change in Durometer, Shore A	Plus or minus 5	D 2240
Tear Strength, min, lb/inch	300	D 624
Accelerated Extraction (CRD-C572)		
Tensile Strength-min, psi	1500	D 638, Type IV

Ultimate Elongation, min, percent	300	D 638, Type IV
Effect of Alkalies (CRD-C572)		
Change in Weight, percent	plus 0.25/minus 0.10	------

B. Preformed Hydrophilic Waterstop

1. Hydrophilic waterstops shall be HF302-Hydro-Flex Waterstop by Henry Co., Earthshield Type NB 190, by JP Specialties, or equal.

2. The cross-sectional area of the waterstop shall not be less than 0.5 square inch.

3. Hydrophilic waterstop shall be the type that expands in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.

4. The waterstop shall be manufactured from butyl or modified chloroprene rubber with hydrophilic properties.

5. The waterstop shall have a delay coating to inhibit initial expansion due to moisture present in fresh concrete.

6. The minimum expansion ratio shall be not less than 2-to-1 volumetric change in distilled water at 70 degrees F (21 degrees C).

7. The bonding agent for hydrophilic waterstop shall be the manufacturer's recommended adhesive for wet, rough concrete.

C. When types of waterstops not listed above are indicated, they shall be subjected to the same requirements as those listed in this Section.

2.03 JOINT SEALANT FOR WATER-BEARING JOINTS

A. The joint sealant shall be a polyurethane polymer designed for bonding to concrete which is continuously submerged in water.

B. No material will be accepted which has an unsatisfactory history as to bond or durability when used in the joints of water-retaining structures.

C. Joint sealant material shall meet the following requirements (73 degrees F and 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200 gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	170 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

D. Polyurethane sealants for waterstop joints in concrete shall conform to the following requirements:

1. Sealant shall be a multi-component polyurethane elastomeric sealant with the physical properties of the cured sealant conforming to or exceeding the requirements of ASTM C 920 or Federal Specification TT-S-0227 E(3) , for multi-component material, as applicable.

2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used, conforming to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.

3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I.

4. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore A hardness range of 35 to 45 shall be used.

5. Primer materials, if recommended by the sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

E. Sealant Manufacturers

1. Sealants shall be PSI-270 by Polymeric Systems Inc., Sikaflex 2C SL/NS, by Sika Corporation, Pelseal (with Viton) 2112/2012 by Pelseal Technologies, LLC, or equal.

F. Sealants for non-waterstop joints in concrete shall be in conformance with the requirements of Section 07 92 13 – Elastomeric Joint Sealants.

2.04 JOINT MATERIALS

A. Bearing Pad

1. The bearing pad shall be neoprene conforming to ASTM D2000 BC 420, 40 durometer hardness, unless otherwise indicated.

B. Neoprene Sponge

1. The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D1056 Type 2C5-E1.

C. Joint Filler

1. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.

2. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.

3. Bituminous fiber type will not be accepted.

4. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise indicated.

2.05 BACKING ROD

A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.

B. The rod material shall be compatible with the joint sealant material, and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.

C. The rod shall be 1/8 inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.06 BOND BREAKER TAPE

A. Bond breaker tape shall be an adhesive-backed glazed butyl or polyethylene tape that will satisfactorily adhere to the premolded joint filler or concrete surface, as required. The tape shall be the same width as the bottom of the groove.

2.07 SLIP DOWELS

A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775.

2.08 PVC TUBING

A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241.

PART 3 -- EXECUTION

3.01 GENERAL

A. Waterstops shall be embedded in the concrete across joints as indicated.

B. Waterstops shall be fully continuous for the extent of the joint.

C. Splices necessary to provide such continuity shall conform to the printed instructions of the waterstop manufacturer.

D. The Contractor shall take suitable precautions and provide means to support and protect the waterstops during the progress of the Work, and shall repair or replace any waterstops damaged during progress of the Work at no additional cost to the Owner.

E. Waterstops shall be stored so as to permit free circulation of air around the waterstop material.

F. When any waterstop is installed in the concrete on one side of a joint while the other portion of the waterstop remains exposed to the atmosphere for more than 2 Days, suitable precautions shall be taken to shade and protect the exposed waterstop from direct rays of the sun during the entire exposure time until the exposed portion of waterstop is embedded in concrete.

3.02 SPLICES IN PVC WATERSTOPS

A. Splices in PVC waterstops shall be performed by heat sealing the adjacent waterstop sections in accordance with the manufacturer's printed recommendations.

B. It is essential that:

1. The material shall not be damaged by heat sealing.

2. The splices shall have a tensile strength of not less than 80 percent of the unspliced material.

3. The continuity of the waterstop ribs and of its tubular center axis shall be maintained.

4. No welding of edges be performed.

C. Butt joints of the ends of 2 identical waterstop sections may be made while the material is in the forms.

D. Other Joints

1. Joints with waterstops involving more than 2 ends to be jointed together, and joints that involve an angle cut, alignment change, or the joining of 2 dissimilar waterstop sections, shall be prefabricated prior to placement in the forms, allowing not less than 24-inch long strips of waterstop material beyond the joint.

2. Upon inspection and approval, such prefabricated waterstop joint assemblies shall be installed in the forms and the ends of the 24-inch strips shall be butt-welded to the straight run portions of waterstop in place in the forms.

E. Where a centerbulb waterstop intersects and is jointed with a non-centerbulb waterstop, care shall be taken to seal the end of the centerbulb, using additional PVC material if needed.

3.03 JOINT CONSTRUCTION

A. Setting Waterstops

1. In order to eliminate faulty installation that may result in joint leakage, particular care shall be taken as to the correct positioning of the waterstops during installation.

2. Adequate provisions shall be made to support and anchor the waterstops during the progress of the Work and to ensure proper embedment in the concrete.

3. The symmetrical halves of the waterstops shall be equally divided between the concrete pours at the joints.

4. The center axis of the waterstops shall be coincident with the joint openings.

5. Thoroughly work the concrete in the vicinity of joints for maximum density and imperviousness.

B. Waterstop Placement

1. In placing waterstops in the forms, means shall be provided to prevent them from being folded over by the concrete as it is placed.

2. Waterstops shall be held in place with light wire ties on 12-inch centers, which shall be passed through hog rings or eyelets at the edge of the waterstop and tied to the curtain of reinforcing steel.

3. Horizontal waterstops, with their flat face in a vertical plane, shall be held in place with continuous supports to which the top edge of the waterstop shall be tacked.

4. In placing concrete around horizontal waterstops with their flat face in a horizontal plane, the concrete shall be worked under the waterstops by hand in order to avoid the formation of air and rock pockets.

C. In placing centerbulb waterstops in expansion joints, the centerbulb shall be centered on the joint filler material.

D. Waterstop in vertical wall joints shall terminate 6 inches from the top of the wall, where such waterstop does not connect with any other waterstop and is not to be connected to a future concrete placement.

E. Joint Location

1. Construction joints and other types of joints shall be provided where indicated.

2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.

3. The location of joints, regardless of type, shall be submitted for acceptance by the Engineer.

F. Joint Preparation

1. Special Care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.

2. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls, including at tops and bottoms of walls.

3. Surfaces shall be prepared in accordance with Section 03 30 50 – Cast-in-Place Concrete.

G. Retrofit Joint Preparation

1. Existing surfaces to receive a retrofit waterstop shall be clean and free from any loose or foreign material.

2. The surface shall be given a light sandblast or hydroblast finish to 1/8-inch amplitude prior to the application of epoxy and waterstop.

H. Joints in Fiber-Reinforced Concrete Pavements and Slabs on Grade

1. Unless indicated otherwise, jointing shall be in accordance with ACI 330.1.

2. Maximum joint spacing shall not exceed 30 times the slab thickness nor 15 feet, whichever is smaller.

3. If jointing requirements are not indicated, the Contractor shall submit drawings describing the proposed jointing.

I. Construction Joint Sealant

1. Construction joints in water-bearing floor slabs and elsewhere, as indicated, shall be provided with tapered grooves which shall be filled with a construction joint sealant.

2. The material used to form the tapered grooves shall be left in the grooves until just before the grooves are cleaned and filled with joint sealant.

3. After removing the forms from the grooves, laitance and fins shall be removed, and the grooves shall be sand blasted.

4. The grooves shall be allowed to thoroughly dry, after which they shall be blown out.

5. Install bond breaker tape at the bottom of the groove.

6. Prime the bonding surfaces and fill the grooves with the construction joint sealant.

7. The primer shall be furnished by the sealant manufacturer, and no sealant shall be used without a primer.

8. Care shall be used to completely fill the sealant grooves.

9. Areas designated to receive a sealant fillet shall be thoroughly cleaned as outlined for the tapered grooves prior to application of the sealant.

J. The primer and sealant shall be placed strictly in accordance with the printed recommendations of the manufacturer, taking special care to properly mix the sealant prior to application.

K. The sides of the sealant groove shall not be coated with bond breaker, curing compound, or any other substance which would interfere with proper bonding of the sealant.

L. The sealant shall achieve final cure at least 7 Days before the structure is filled with water.

M. The sealant shall be installed by a competent worker certified by the sealant manufacturer.

N. Mixing

1. Catalyst-cured, 2-part materials shall be thoroughly and uniformly mixed, and special care shall be taken to properly mix the sealer before its application.

O. Failure to Cure

1. Any joint sealant that fails to fully and properly cure after the manufacturer's recommended curing time for the conditions of the Work shall be completely removed, and the groove shall be thoroughly sandblasted to remove traces of the uncured or partially cured sealant and primer.

2. The groove shall be re-sealed with the indicated joint sealant.

3. Costs of such removal, joint treatment, re-sealing, and appurtenant Work shall be the Contractor’s responsibility as part of the Work.

P. Hydrophilic Waterstop

1. Where a hydrophilic waterstop is indicated, it shall be installed in accordance with the manufacturer's instructions and recommendations except as may be modified in this Section.

2. When requested by the Engineer, the Contractor shall arrange for the manufacturer to furnish technical assistance in the field.

3. Hydrophilic waterstop shall only be used where complete confinement by concrete is provided.

4. Hydrophilic waterstop shall not be used in expansion or contraction joints nor in the first 6 inches of a non-intersecting joint.

5. Location

a. The hydrophilic waterstop shall be located as near as possible to the center of the joint, and it shall be continuous around the entire joint.

b. The minimum distance from the edge of the waterstop to the face of the member shall be 5 inches.

6. Placement

a. Where the thickness of the concrete member to be placed on the hydrophilic waterstop is less than 12 inches, the waterstop shall be placed in grooves formed or ground into the concrete.

b. The groove shall be at least 3/4 inch deep and 1-1/4 inches wide.

c. When placed in the groove, the minimum distance from the edge of the waterstop to the face of the member shall be 2-1/2 inches.

7. Where a hydrophilic waterstop is used in combination with PVC waterstop, the hydrophilic waterstop shall overlap the PVC waterstop for a minimum of 6 inches and shall be adhered to PVC waterstop by a single component water-swelling sealant as recommended by the manufacturer.

8. Follow manufacturer’s recommendations for application in cold weather (less than 45 degrees F).

9. Preparation

    a. The concrete surface under the hydrophilic waterstop shall be smooth and uniform, and the concrete shall be ground smooth if needed.

    b. Alternatively, the hydrophilic waterstop shall be bonded to the surface using an epoxy grout that completely fills voids and irregularities beneath the waterstop material.

    c. Prior to installation, the concrete surface shall be wire brushed to remove any laitance or other materials that may interfere with the bonding of epoxy.

10. Securing

    a. The hydrophilic waterstop shall be secured in place with concrete nails and washers at 12-inch maximum spacing.

    b. The above requirement shall be in addition to the adhesive recommended by the manufacturer.

Q. Retrofit Waterstop

1. Retrofit waterstops shall be set in a bed of epoxy over a sandblasted surface with stainless steel batten bars and 1/4-inch diameter stainless steel anchors at 6 inches on-center, staggered, and in accordance with the manufacturer's written recommendations.

END OF SECTION

SECTION 03 21 00 – REINFORCEMENT BARS

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide reinforcement steel and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
03 60 00	Grouting

C. Reference Standards

1. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

American Concrete Institute (ACI)	
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 318	Building Code Requirements for Structural Concrete
ASTM International (ASTM)	
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706	Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 775	Epoxy - Coated Reinforcing Steel Bars
ASTM A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
American Welding Society (AWS)	
AWS D1.4	Structural Welding Code – Reinforcing Steel
Concrete Reinforcing Steel Institute (CRSI)	
CRSI	Manual of Standard Practice
International Code Council (ICC)	

IBC	2021 International Building Code
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Furnish shop bending diagrams, placing lists, and drawings of reinforcement steel prior to fabrication.

2. Diagrams

a. The shop bending diagrams shall show the actual lengths of bars to the nearest inch, measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface.

b. Include bar placement diagrams that clearly indicate the dimensions of each bar splice.

3. Reinforcement

a. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the Contractor of the Notice to Proceed.

b. Said details of reinforcement steel for fabrication and erection shall conform to the CRSI Manual of Standard Practice, and the indicated requirements.

c. Mill certificates, including reinforcing steel yield and tensile strength test data.

4. Mechanical Couplers

a. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit the following items:

1) manufacturer's literature containing instructions and recommendations for installation for each type of coupler used;

2) certified test reports that verify the load capacity of each type and size of coupler used; and

3) Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

5. Welding

a. If reinforcement steel is to be spliced by welding at any location, submit mill test reports containing the information necessary for determination of the carbon equivalent per AWS D1.4.

b. Submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.

c. If reinforcement steel is spliced by welding at any location, submit certifications of procedure qualifications for each welding procedure and certification of welder qualifications, for each welding procedure and for each welder performing on the Work.

1.04 QUALITY ASSURANCE

A. Materials Testing

1. If requested by the Engineer, furnish samples from each heat of reinforcement steel in a quantity adequate for testing.

2. Costs of initial tests will be paid by the Owner.

3. Costs of additional tests if material fails initial tests shall be the Contractor's responsibility.

B. Welding

1. Welder qualifications and procedure qualifications shall be as indicated in AWS D1.4.

2. If requested by the Engineer, furnish samples of each type of welded splice in a quantity and of dimensions adequate for testing.

3. At the discretion of the Engineer, radiographic testing of direct butt-welded splices will be performed.

4. Provide assistance necessary to facilitate testing.

5. Repair welds that fail to meet AWS D1.4.

6. The costs of testing will be paid by the Owner, but the costs of tests that show failure to meet requirements shall be the Contractor's responsibility.

PART 2 -- PRODUCTS

2.01 MATERIAL REQUIREMENTS

A. Materials that may remain or leave residues on or within the concrete shall be certified as compliant with NSF/ANSI 61.

2.02 REINFORCEMENT STEEL

A. Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Deformed Bar Reinforcement

a. Deformed bar reinforcement shall conform to ASTM A706 for Grade 60 reinforcement, unless otherwise indicated.

b. Except as indicated below, deformed bar reinforcement conforming to ASTM A615 will be permitted provided both of the following material property requirements are met:

1) The actual yield strength based on mill tests does not exceed 78,000 psi.

2) The ratio of the actual tensile strength to the actual yield strength is not less than 1.25.

c. Welded Reinforcement

1) Deformed bar reinforcement that is welded shall conform to ASTM A706 for Grade 60 reinforcement, unless otherwise indicated.

2) The carbon equivalent in reinforcing that is welded shall not exceed 0.55 percent.

2. Spiral Reinforcement

a. Spiral reinforcement shall conform to one of the following:

1) ASTM A615 for plain or deformed bars.

2) ASTM A706 for plain or deformed bars.

3) ASTM A1064 for plain wire.

b. Welded Reinforcement

1) Spiral reinforcement that is welded shall conform to ASTM A706, unless otherwise indicated.

2) The carbon equivalent in spiral reinforcing that is welded shall not exceed 0.55 percent

3. Welded Wire Reinforcement

a. Welded wire reinforcement shall conform to ASTM A1064 and the indicated Details.

b. Welded wire reinforcement with longitudinal wire of W4 size wire and smaller shall be in flat sheets or in rolls with a core diameter of not less than 10-in.

c. Welded wire reinforcement with longitudinal wires larger than W4 size shall be in flat sheets only.

B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement.

2. Bar Supports

a. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars.

b. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 1/2 inch from the concrete surface.

c. Plastic shall be gray in color.

3. Concrete Blocks

a. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located.

b. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A775.

2.03 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the Engineer.

B. The couplers shall develop a tensile strength and compressive strength that exceeds 125 percent of the specified yield strength of the reinforcement bars being spliced at each splice and shall develop the specified tensile strength of the reinforcement bars being spliced at each splice.

C. Multi-Component Couplers

1. Where the type of coupler used is composed of more than one component, components required for a complete splice shall be provided.

2. This shall apply to mechanical splices, including those splices intended for future connections.

D. Connection

1. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection.

2. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.

E. Couplers shall be Lenton Form Saver by Erico Products, Dowel Bar Splicer System by Dayton/Richmond, or equal.

2.04 WELDED SPLICES

A. Welded splices shall be provided where indicated and where approved by the Engineer.

B. Welded splices of reinforcement steel shall develop a tensile strength that exceeds 125 percent of the specified yield strength of the reinforcement bars that are connected.

C. Materials as required to conform the welded splices to AWS D1.4 shall be provided.

2.05 EPOXY GROUT

A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled.

B. Epoxy grout shall be in conformance with the requirements of Section 03 60 00 - Grouting.

PART 3 -- EXECUTION

3.01 GENERAL

A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the indicated supplementary requirements.

3.02 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 318 and the CRSI Manual of Standard Practice, except as modified by the Drawings.

2. Bars shall be bent cold.

3. Bars shall be bent in accordance with the requirements of ACI 318.

4. Fabricate reinforcement bars for structures in accordance with accepted bending diagrams, placing lists, and placing drawings.

B. Fabricating Tolerances

1. Bars used for concrete reinforcement shall conform to the following fabricating tolerances:

a. Sheared Length: plus and minus 1-in

b. Depth of Truss Bars: plus zero, minus ½-in

c. Stirrups, Ties and Spirals: plus and minus ½-in

d. Other Bends: plus and minus 1-in

3.03 PLACEMENT

A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement using annealed iron wire ties or suitable clips at intersections.

B. Reinforcement steel shall be supported by concrete, plastic or metal support spacers, or metal hangers that are sufficiently strong and rigid to prevent any displacement of the reinforcement steel.

C. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous.

D. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks.

E. For concrete over formwork, provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

F. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies

a. permitted at any location except where architectural finish is required

b. required for slabs on grade and surfaces in contact with or above ozonated process water

2. Wire bar supports will be permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic bar supports will be permitted at every location except on-grade.

G. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

H. Bars additional to those indicated that may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor at no additional expense to the Owner.

I. Except where in conflict with the Building Code, unless otherwise indicated, reinforcement placing tolerances shall be within the limits indicated in ACI 318.

J. Moving Bars

1. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items.

2. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the Engineer.

K. Welded Wire Reinforcement

1. Welded wire reinforcement placed over horizontal forms shall be supported on slab bolsters.

2. Slab bolsters shall be spaced not more than 30-in on centers, shall extend continuously across the entire width of the reinforcement mat, and shall support the reinforcement mat in the plane indicated.

3. Welded wire reinforcement placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3 feet on centers in any direction.

4. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

L. Storage and Handling

1. Epoxy-coated reinforcing bars shall be stored, transported, and placed in such a manner as to avoid chipping of the epoxy coating.

2. Non-abrasive slings made of nylon and similar materials shall be used.

3. Specially coated bar supports shall be used.

4. Chips or cracks in the epoxy coating shall be repaired with a compatible epoxy repair material prior to placing concrete.

M. Accessory Spacing

1. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars.

2. When used to space the reinforcing bars from wall forms, the forms and bars shall be located such that there is no deflection of the accessory when the forms are tightened into position.

3.04 SPACING OF BARS

A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.

B. Where reinforcement in beams or girders is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.

C. In columns, the clear distance between longitudinal bars shall be not less than 1-1/2 times the bar diameter, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than 1-1/2 inches.

D. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

3.05 SPLICING

A. General

1. Reinforcement bar splices shall only be used at indicated locations.

2. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the Engineer.

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318 for a Class B splice.

2. Welded Wire Reinforcement

a. Laps of welded wire reinforcement shall be in accordance with ACI 318.

b. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet.

c. Wires shall be staggered and tied in such a manner that they cannot slip.

3. Splices in column spiral reinforcement, when necessary, shall be made by welding or by a lap of 1-1/2 turns.

C. Bending or Straightening

1. Reinforcement shall not be straightened or re-bent in a manner which will injure the material.

2. Bars shall be bent or straight as indicated.

3. Do not use bends different from the bends indicated.

4. Bars shall be bent cold, unless otherwise permitted by the Engineer.

5. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the Engineer.

D. Couplers

1. Couplers that are located at a joint face shall be of a type that can be set either flush or recessed from the face as indicated.

2. The couplers shall be sealed during concrete placement to completely eliminate concrete, or cement paste from entering.

3. Couplers intended for future connections shall be recessed a minimum of 1/2 inch from the concrete surface.

4. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.

5. Threaded couplers shall be plugged.

E. Unless indicated otherwise, mechanical coupler spacing, and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.

3.06 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete has been placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

C. Where there is delay in depositing concrete, the reinforcement shall be re-inspected and, if necessary, re-cleaned.

3.07 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

A. Hole Preparation

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4 inch greater than the diameter of the outer surface of the reinforcing bar deformations.

2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.

3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.

4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling, and the location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars. Final hole locations shall be as reviewed and accepted by the Engineer.

5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

B. Embedment

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole.

2. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets.

3. The hole shall be filled to a depth that ensures excess material will be expelled from the hole during dowel placement.

4. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy.

5. The bar shall be inserted slowly enough to avoid developing air pockets.

END OF SECTION

SECTION 03 30 50 – CAST-IN-PLACE CONCRETE

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide cast-in-place concrete, joints in concrete, reinforcement steel and appurtenant work, formwork, bracing, shoring, supports, and shall design and construct falsework, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
03 60 00	Grouting
07 92 13	Elastomeric Joint Sealants

C. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

D. Reference Codes

American Concrete Institute (ACI)	
ACI 117	Specification for Tolerances for Concrete Construction and Materials
ACI 301	Specifications for Structural Concrete
ACI 304.2R	Placing Concrete by Pumping Methods.
ACI 306.1	Standard Specification for Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI 347	Guide to Formwork for Concrete
ASTM International (ASTM)	
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A 706	Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A 775	Epoxy Coated Reinforcing Steel Bars.
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Concrete Aggregates.
ASTM C 39	ASTM C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	Ready-Mixed Concrete
ASTM C 143	Standard Test Method for Slump of Hydraulic Cement Concrete.
ASTM C150	Standard Specification for Portland Cement
ASTM C 156	Standard Test Method for Water Retention by Concrete Curing Materials
ASTM C 260	Air Entraining Admixtures for Concrete
ASTM C 309	Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	Chemical Admixtures for Concrete
ASTM C 1077	Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E1745	Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
American Welding Society (AWS)	
AWS D1.4	Structural Welding Code – Reinforcing Steel
Concrete Reinforcing Steel Institute (CRSI)	
CRSI	Manual of Standard Practice
International Code Council (ICC)	
IBC 2018	International Building Code
National Institute of Standards and Technology (NIST)	
Voluntary Product Standard PS 20: American Softwood Lumber Standard.	
Voluntary Product Standard PS 1: Structural Plywood.	

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

B. Shop Drawings

1. Detailed drawings of the falsework proposed to be used. Such drawings shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, and typical soil conditions.

2. Shop bending diagrams, placing lists, and drawings of reinforcing steel prior to fabrication.

3. Details of the concrete reinforcing steel and concrete inserts shall be submitted at the earliest possible date after receipt by the Contractor of the Notice to Proceed. Details of reinforcing steel for fabrication and erection shall conform to the CRSI Manual of Standard Practice and the requirements herein. The shop bending diagrams shall show the actual lengths of bars, to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. Include bar placement diagrams which clearly indicate the dimensions of each bar splice.

4. Where mechanical couplers are required or permitted to be used to splice reinforcing steel, submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports which verify the load capacity of each type and size of coupler used; and Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.

5. If reinforcement steel is spliced by welding at any location, submit mill test reports that contain the information necessary for the determination of the carbon equivalent per AWS D1.4. The Contractor shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable. The Contractor shall submit certifications of procedure qualifications for each welding procedure used and welder qualifications, for each welding procedure, and for each welder performing the Work. Such qualifications shall be as specified in AWS D1.4.

6. Manufacturer's information demonstrating compliance with requirements of the following:

    a. Bearing pads

    b. Neoprene sponge

    c. Preformed joint filler

    d. Backing rod

    e. Bond breaker

    f. Slip dowels

    g. PVC tubing

    h. Form ties and related accessories

    i. Form gaskets

    j. Form release agent

    k. List of form materials and locations of use

    l. Mill tests for cement

m. Admixture certification. Chloride ion content shall be included.

n. Aggregate gradation test results and certification

o. Materials and methods for curing

p. Vapor retarder

7. Placement drawings showing the location and type of joints for each structure.

C. Mix Designs: Prior to beginning the Work, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete. The mix designs shall be checked by an independent testing laboratory acceptable to the Engineer. Costs related to such checking shall be the Contractor's responsibility. When a water reducing admixture is to be used, the Contractor shall furnish mix designs for concrete both with and without the admixture.

D. Delivery Tickets: Where ready-mix concrete is used, the Contractor shall furnish certified delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state certified equipment used for measuring, and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amounts of water in the aggregate, added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each certificate shall state the mix number, total yield in cubic yards, and the time of day to the nearest minute, corresponding to the time when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.

1.04 QUALITY ASSURANCE

A. Testing of Reinforcing Steel

1. If requested by the Engineer, the Contractor shall furnish samples from each heat of reinforcing steel in a quantity adequate for testing. Costs of initial tests will be paid by the Owner. Costs of additional tests, if material fails initial tests, shall be the Contractor's responsibility.

2. If requested by the Engineer, the Contractor shall furnish samples of each type of welded splice used in the Work in a quantity and of dimensions adequate for testing. At the discretion of the Engineer, radiographic testing of direct butt welded splices will be performed. The Contractor shall provide assistance necessary to facilitate testing. The Contractor shall repair any weld that fails to meet the requirements of AWS D1.4. The costs of testing will be paid by the Owner; but the costs of tests that fail to meet requirements shall be the Contractor's responsibility.

B. Testing of Materials

1. Tests on component materials and for compressive strength of concrete will be performed as indicated herein. Tests for determining slump will be in accordance with the requirements of ASTM C143.

2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness in accordance with ASTM C33.

3. The cost of laboratory tests on cement, aggregates, and concrete, will be paid by the Owner. However, the Contractor shall pay the cost of any additional tests and investigations on Work that does not meet the Specifications. The laboratory will meet or exceed the requirements of ASTM C1077.

4. Concrete for testing shall be furnished by the Contractor at no cost to the Owner, and the Contractor shall assist the Engineer in obtaining samples and disposal and cleanup of excess material.

C. Inspections: Continuous inspection by a special inspector approved by the local building department having jurisdiction and by the Engineer will be required where necessary to conform to code requirements. Costs of the special inspector shall be paid for by the Owner. Inspection reports shall be submitted to the Engineer. The special inspector shall observe the following Work for conformance with the Drawings and Specifications:

1. During the preparation and taking of required test specimens.

2. Placing of concrete except sitework concrete fully supported on earth.

D. Field Compression Tests

1. Compression test specimens shall be taken during construction from the first placement of each class of concrete herein and at intervals thereafter as selected by the Engineer to ensure continued compliance with these Specifications. Each set of test specimens will be a minimum of 4 cylinders.

2. Compression test specimens for concrete will be made in accordance with ASTM C31. Specimens will be 6-inches diameter by 12-inches high cylinders.

3. Compression tests will be performed in accordance with ASTM C39. One test cylinder will be tested at 7 Days and 2 at 28 Days. The remaining cylinder will be held to verify test results, if needed.

E. Evaluation and Acceptance of Concrete

1. Evaluation and acceptance of the compressive strength of concrete will be according to the requirements of ACI 318 and as indicated herein.

2. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.

3. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement as part of the Work.

F. Construction Tolerances: The Contractor shall set and maintain concrete forms and perform finishing operations so that the concrete is within the tolerances herein. Surface defects and irregularities are defined as finishes and are to be distinguished from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated. Where tolerances are not indicated, permissible deviations will be in accordance with ACI 117.

1. The variation from required lines or grades shall not exceed 1/4-inch in 10-feet and there shall be no offsets or visible waviness in the finished surface.

PART 2 -- PRODUCTS

2.01 FORM AND FALSEWORK MATERIALS

A. Except as otherwise expressly accepted by the Engineer, lumber for use as forms, shoring, or bracing shall be new material.

B. Materials for concrete forms, formwork, and falsework shall conform to the following requirements:

1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with Voluntary Product Standard PS 20.

2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork and shall conform to the requirements of Voluntary Product Standard PS 1 – Exterior Plywood for Concrete Forms, Class I, and shall be edge sealed.

3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade required. Metal forms shall be an approved type that will accomplish such results. Wood forms for surfaces to be painted shall confirm to the requirements of Voluntary Product Standard PS 1 – Exterior Plywood for Concrete Forms, Class I, Medium Density Overlaid (MDO) Grade

C. Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to a 1/2-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.

D. Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50 psf (minimum). The minimum design load for combined dead and live loads shall be 100 psf.

2.02 FORM TIES

A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form-tie fasteners having a circular cross-section shall not exceed 1-1/2 inches; and such fasteners shall be such as to leave holes of regular shape for reaming. Form ties shall be ST-4 Hex Head Snaptie by MeadowBurke, A3 Snap-Ties by Dayton Superior, or equal.

B. Removable taper ties may be used when approved by the Engineer. Taper ties shall be HD-9Taper-Tie by MeadowBurke, D9 Taper-Tie by Dayton Superior, or equal.

2.03 REINFORCEMENT STEEL

A. Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Deformed Bar Reinforcement

a. Deformed bar reinforcement shall conform to ASTM A706 for Grade 60 reinforcement, unless otherwise indicated.

b. Except as indicated below, deformed bar reinforcement conforming to ASTM A615, will be permitted provided both of the following material property requirements are met:

1) The actual yield strength based on mill tests does not exceed 78,000 psi.

2) The ratio of the actual tensile strength to the actual yield strength is not less than 1.25.

c. Welded Reinforcement

1) Deformed bar reinforcement that is welded shall conform to ASTM A706 for Grade 60 reinforcement, unless otherwise indicated.

2) The carbon equivalent in reinforcing that is welded shall not exceed 0.55 percent.

2. Spiral Reinforcement

a. Spiral reinforcement shall conform to one of the following:

1) ASTM A615 for plain or deformed bars.

2) ASTM A706 for plain or deformed bars.

3) ASTM A1064 for plain wire.

b. Welded Reinforcement

1) Spiral reinforcement that is welded shall conform to ASTM A706, unless otherwise indicated.

2) The carbon equivalent in spiral reinforcing that is welded shall not exceed 0.55 percent.

3. Welded wire fabric reinforcement shall conform to the requirements of ASTM A1064 and the details indicated. Welded wire fabric with longitudinal wire of W4 size wire and smaller shall be either furnished in flat sheets or in rolls with a core diameter of not less than 10-inches. Welded wire fabric with longitudinal wires larger than W4 size shall be furnished in flat sheets only.

B. Accessories

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice including special requirements for supporting epoxy coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

2. Concrete blocks (dobies) used to support and position reinforcement steel shall have the same or higher compressive strength than required for the concrete in which they are located. Where concrete blocks are used on concrete surfaces exposed to view, the color and texture of the concrete blocks shall match that required for the finished surface. Wire ties shall be embedded in concrete block bar supports.

C. Epoxy coating for reinforcing and accessories, where indicated, shall conform to ASTM A 775.

2.04 MECHANICAL COUPLERS

A. Mechanical couplers shall be provided where indicated and where approved by the Engineer. Couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcing bars being spliced at each splice.

2.05 WELDED SPLICES

A. Welded splices shall be provided where indicated and where approved by the Engineer. Welded splices of reinforcement steel shall develop a tensile strength exceeding 125 percent of the yield strength of the reinforcing bars that are connected.

B. Materials required to perform the welded splices to the requirements of AWS D1.4 shall be provided.

2.06 CONCRETE MATERIALS

A. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Only one brand of cement shall be used. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.

B. Materials for the Work shall comply with the requirements of ACI 301, as applicable.

C. Storage of materials shall conform to the requirements of ACI 301.

D. Materials for concrete shall conform to the following requirements:

1. Cement shall be standard brand portland cement conforming to ASTM C150, Type II or Type V.

2. Water shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (over 1000 mg/l TDS) shall not be used.

3. Aggregates shall be obtained from pits acceptable to the Engineer, shall be non-reactive, and shall conform to ASTM C33. Maximum size of coarse aggregate shall be as indicated. Lightweight sand for fine aggregate will not be permitted.

4. Ready-mix concrete shall conform to the requirements of ASTM C94.

5. Air-entraining agent meeting the requirements of ASTM C260 shall be used. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 3 percent. The Owner reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement. Air entraining agent shall be MasterAir AE 90 by Master Builders Solutions US LLC, Daravair 1000 by GCP Applied Technologies, Sika AEA-14 by Sika Corporation, or equal.

6. Admixtures: Admixtures may be added at the Contractor's option to control the set, affect water reduction, and increase workability. In either case, the addition of an admixture shall be at the Contractor's expense. The use of an admixture shall be subject to acceptance by the Engineer. Concrete containing an admixture shall be first placed at a location determined by the Engineer. If the use of an admixture is producing an inferior end result, the Contractor shall discontinue use of the admixture. Admixtures shall conform to the requirements of ASTM C494. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used. Admixtures shall contain no free chloride ions, shall be non-toxic after 30 Days, and shall be compatible with and made by the same manufacturer as the air entraining admixture.

    a. Concrete shall not contain more than one water-reducing admixture. Concrete containing an admixture shall be first placed at a location determined by the Engineer.

    b. Set controlling admixture may be either with or without water-reducing properties. Where the air temperature at the time of placement is expected to be consistently over 80 degrees F, a set retarding admixture such as Plastocrete-161 by Sika Corporation, MasterPozzolith R300 by Master Builders Solutions US LLC, Daratard by GCP Applied Technologies, or equal shall be used. Where the air temperature at the time of placement is expected to be consistently under 40 degrees, a set accelerating admixture such as Plastocrete-161 by Sika Corporation, MasterSet FP 20 by Master Builders Solutions US LLC, Polarset by GCP Applied Technologies, or equal shall be used.

c. Normal range water reducer shall conform to ASTM C 494, Type A. It shall be WRDA 79 by GCP Applied Technologies, MasterPozzolith 322 by Master Builders Solutions US LLC, Plastocrete-161 by Sika Corporation, or equal. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations.

7. Calcium Chloride: Calcium chloride will not be permitted in concrete.

2.07 CURING MATERIALS

A. Materials for curing concrete shall conform to the following requirements and ASTM C309:

1. Curing compounds shall be white-pigmented and resin-based. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be Kurez VOX White Pigmented by Euclid Chemical Company, Cure R-2 by L&M Construction Chemicals, 1200-White by W.R. Meadows, or equal. When curing compound must be removed for finishes or grouting, curing compounds shall be Kurez DR VOX by Euclid Chemical Company, MasterKure CC 1315WB by Master Builders Solutions US LLC, L&M Cure R by L&M Construction Chemicals, 1100-Clear by WR Meadows, or equal. Curing compounds shall meet local VOC requirements.

2. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with the requirements of ASTM C 156 shall not exceed 0.055 grams per square centimeter of surface.

3. Evaporation retardant shall be a material such as MasterKure ER 50 by Master Builders Solutions US LLC, Eucobar by Euclid Chemical Company, L&M E-CON by Laticrete, or equal.

2.08 JOINT MATERIALS

A. Materials for joints in concrete shall conform to the following requirements:

1. Joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 for Type I, except as otherwise indicated.

2. Elastomeric joint sealer shall conform to the requirements of Section 07 92 13 – Elastomeric Joint Sealants.

3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement due to expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth hereinafter, if testing is required by the Engineer.

2.09 MISCELLANEOUS MATERIALS

A. Dampproofing agent shall be an asphalt emulsion such as Hydrocide 600 by ChemRex Sonneborn, Dehydratine75 Emulsified Asphalt by Euclid Chemical Company, Sealmastic Emulsion by W. R. Meadows Inc., or equal.

B. Epoxy adhesives shall be the following products:

1. For bonding freshly-mixed, plastic concrete to hardened concrete, Sikadur 32 Hi-Mod Epoxy Adhesive by Sika Corporation, MasterEmaco ADH 326 by Master Builders Solutions US LLC; BurkEpoxy MV by Burke by Edoco, or equal.

2. or bonding hardened concrete or masonry to steel, Sikadur 31 Hi-Mod Gel by Sika Corporation, BurkEpoxy NS by Burke by Edoco, Concresive Paste (LPL) by Chem Rex MBT; or equal.

C. Epoxy grout for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements in Section 03 60 00 - Grouting.

D. Vapor Retarder

1. The vapor retarder shall be a plastic sheet meeting the Class A permeance and strength requirements of ASTM E1745. The minimum thickness shall be 10 mils.

2. The vapor retarder shall be Griffolyn Type-65 G by Reef Industries, Inc., or equal.

2.10 CONCRETE DESIGN REQUIREMENTS

A. General

1. Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The proportions shall be changed whenever necessary or desirable to meet the required results at no additional cost to the Owner. Mix changes shall be subject to review by the Engineer.

2. The Contractor is cautioned that the limiting parameters below are NOT a mix design. Admixtures may be required to achieve workability required by the Contractor's construction methods and aggregates. The Contractor is responsible for providing concrete with the required workability.

B. Water-Cement Ratio and Compressive Strength: The minimum compressive strength and cement content of concrete shall be not less than the following tabulation.

Type of Work	Class of Concrete Min 28-Day Compressive Strength, psi	Max Size Aggregate in	Cement Content Per cu yd, lbs	Max W/C Ratio (by weight)
Structural concrete	4,500	1	564 (min)	0.42
Sitework concrete	3,000	1	470 (min)	0.50
Lean concrete	2,000	1	376 (min)	0.60

2.11 CONSISTENCY

A. Consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143. The slumps shall be as follows:

Part of Work	Slump (in
All concrete unless indicated otherwise	3-inches plus or minus 1-inch
Ductbank and pipe encasement	5-inches plus or minus 1-inch

2.12 MEASUREMENT OF CEMENT AND AGGREGATE

A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the Contractor and acceptable to the Engineer; provided that, where batches are so proportioned as to contain an integral number of conventional sacks of cement and the cement is delivered at the mixer in the original unbroken sacks, the weight of the cement contained in each sack may be taken without weighing as 94 pounds.

2.13 MEASUREMENT OF WATER

A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the Engineer and capable of measuring the water in variable amounts within a tolerance of one percent.

2.14 READY-MIXED CONCRETE

A. At the Contractor's option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, placing, the supplementary requirements as required herein, and is in accordance with ASTM C 94.

B. Ready-mixed concrete shall be delivered to the Work, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever comes first. In hot weather, under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85 degrees F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be of the resettable, recording type, and shall be mounted in the driver's cab. The counter shall be actuated at the time of starting the mixer at mixing speed.

D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.

E. Each batch of ready-mixed concrete delivered to the Work shall be accompanied by a delivery ticket furnished to the Engineer in accordance with the requirements above.

F. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the Engineer.

PART 3 -- EXECUTION

3.01 GENERAL FORMWORK REQUIREMENTS

A. Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The Contractor shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the Work and replaced. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state and federal regulations. Design, construction, maintenance, preparation, and removal of forms shall be in accordance with ACI 347 and the requirements herein.

B. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete.

3.02 CONSTRUCTION

A. Vertical Surfaces: Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.

B. Construction Joints: Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the Engineer. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory affect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

C. Form Ties

1. Embedded Ties: Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties which cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. Removable Ties: Where taper ties are approved for use, after the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink or regular cement grout. Exposed faces of walls shall have at least the outer 2-inches of the exposed face filled with a cement grout which shall match the color and texture of the surrounding wall surface.

3.03 REUSE OF FORMS

A. Forms may be reused only if in good condition and only if acceptable to the Engineer. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view.

3.04 REMOVAL OF FORMS

A. Careful procedures for the removal of forms shall be strictly followed, and this Work shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted. Members which must support their own weight shall not have their forms removed until they have attained at least 75 percent of the 28-Day strength of the concrete. Forms for vertical walls and columns shall remain in place at least 48 hours after the concrete has been placed. Forms for parts of the Work not specifically mentioned herein shall remain in place for periods of time as recommended in ACI 347.

3.05 GENERAL REINFORCEMENT REQUIREMENTS

A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the requirements of the Building Code and the supplementary requirements indicated herein.

3.06 FABRICATION

A. General

1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with the CRSI Manual of Standard Practice and ACI 318, except as modified by the Drawings.

2. The Contractor shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings. Said drawings, diagrams, and lists shall be prepared by the Contractor.

3. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

B. Bending or Straightening: Reinforcement shall not be straightened or rebent in a manner that will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the Engineer.

3.07 PLACING

A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Reinforcement steel shall be supported by concrete, plastic or metal supports, spacers or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties which are embedded in the blocks. For concrete over formwork, the Contractor shall provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. The portions of accessories in contact with the formwork shall be made of concrete, plastic, or steel coated with a 1/8-inch minimum thickness of plastic which extends at least 1/2-inch from the concrete surface. Plastic shall be gray in color.

C. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

D. Bars additional to those indicated which may be found necessary or desirable by the Contractor for the purpose of securing reinforcement in position shall be provided by the Contractor as part of the Work.

E. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits specified in ACI 318 except where in conflict with the requirements of the Building Code.

F. The minimum spacing requirements of ACI 318 shall be followed for reinforcing steel.

G. Welded wire fabric reinforcement placed over horizontal forms shall be supported on slab bolsters having gray, plastic-coated standard type legs. Slab bolsters shall be spaced not more than 30-inches on centers, shall extend continuously across the entire width of the reinforcing mat, and shall support the reinforcing mat in the plane indicated.

H. Welded wire fabric placed over the ground shall be supported on wired concrete blocks (dobies) spaced not more than 3-feet on centers in any direction. The construction practice of placing welded wire fabric on the ground and hooking into place in the freshly placed concrete shall not be used.

3.08 SPLICING

A. General: Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be reviewed and accepted by the Engineer.

B. Splices of Reinforcement

1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318 for a Class B splice.

2. Welded splices shall be performed in accordance with AWS D1.4.

3. Laps of welded wire fabric shall be in accordance with ACI 318. Adjoining sheets shall be securely tied together with No. 14 tie wire, one tie for each 2 running feet. Wires shall be staggered and tied in such a manner that they cannot slip.

3.09 CLEANING AND PROTECTION

A. Reinforcement steel shall always be protected from conditions conductive to corrosion until concrete is placed around it.

B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcing shall be reinspected and, if necessary recleaned.

3.10 PROPORTIONING AND MIXING

A. Proportioning: Proportioning of the concrete mix shall conform to the requirements of ACI 301.

B. Mixing: Mixing of concrete shall conform to the requirements of ACI 301.

C. Slump: Slumps shall be as indicated herein.

D. Retempering: Retempering of concrete or mortar which has partially hardened shall not be permitted.

3.11 PREPARATION OF SURFACES FOR CONCRETING

A. General: Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

B. Joints in Concrete: Concrete surfaces upon or against which concrete is to be placed, where the placement of the concrete has been stopped or interrupted so that, as determined by the Engineer, the new concrete cannot be incorporated integrally with that previously placed, are defined as construction joints. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, and foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.

C. Placing Interruptions: When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means, that will secure proper union with subsequent Work; provided that construction joints shall be made only where acceptable to the Engineer.

D. Embedded Items

1. No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the Engineer at least 4 hours before placement of concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

2. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated or by Shop Drawings and shall be acceptable to the Engineer before any concrete is placed. Accuracy of placement is the responsibility of the Contractor.

E. Casting New Concrete Against Old: Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days of age), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting (exposing aggregate) prior to the application of an epoxy bonding agent. Application shall be according to the bonding agent manufacturer's instructions and recommendations.

F. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the Work. No concrete shall be deposited underwater nor shall the Contractor allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to the review of the Engineer.

G. Corrosion Protection: Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.

H. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided for during the placing of concrete.

I. Anchor bolts shall be accurately set and shall be maintained in position by templates while being embedded in concrete.

3.12 HANDLING, TRANSPORTING, AND PLACING

A. General: Placing of concrete shall conform to the applicable requirements of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.

B. Non-Conforming Work or Materials: Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the Work. Concrete which is not placed in accordance with these Specifications or which is of inferior quality shall be removed and replaced.

C. Unauthorized Placement: No concrete shall be placed except in the presence of a duly authorized representative of the Engineer. The Contractor shall notify the Engineer in writing at least 24 hours in advance of placement of any concrete.

D. Placement in Wall and Column Forms

1. Concrete shall not be dropped through reinforcement steel or into any deep form nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, some means such as the use of hoppers and, if necessary, vertical ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete exceed 4-feet in walls and 8-feet in columns below the ends of ducts, chutes, or buggies. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the deck or runway.

2. The surface of the concrete shall be level whenever a run of concrete is stopped. To insure a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel, and laitance shall be removed.

E. Conveyor Belts and Chutes: Ends of chutes, hopper gates, and other points of concrete discharge throughout the Contractor's conveying, hoisting, and placing system shall be so designed and arranged that concrete passing from them will not fall separated into whatever receptacle immediately receives it. Conveyor belts, if used, shall be of a type acceptable to the Engineer. Chutes longer than 50-feet will not be permitted. Minimum slopes of chutes shall be such that concrete of the required consistency will readily flow in them. If a conveyor belt is used, it shall be wiped clean by a device operated in such a manner that none of the mortar adhering to the belt will be wasted. Conveyor belts and chutes shall be covered.

F. Temperature of Concrete: The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 40 degrees F in moderate weather, and not less than 50 degrees F in weather during which the mean daily temperature drops below 40 degrees F. Concrete ingredients shall not be heated to a temperature higher than that necessary to keep the temperature of the mixed concrete, as placed, from falling below the required minimum temperature. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, the Contractor shall employ effective means, such as precooling of aggregates and mixing water, using ice, or placing at night, as necessary to maintain the temperature of the concrete, as it is placed, below 90 degrees F. The Contractor shall be entitled to no additional compensation on account of the foregoing requirements.

G. Cold Weather Placement

1. Placement of concrete shall conform to ACI 306.1. and the following.

2. Earth foundations shall be free from frost or ice when concrete is placed upon or against them.

3. Maintain the concrete temperature above 50 degrees F for at least 72-hours after placement.

3.13 PUMPING OF CONCRETE

A. General: If the pumped concrete does not produce satisfactory end results, the Contractor shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.

B. Pumping Equipment

1. The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder only in case the other one is not functioning. In lieu of this requirement, the Contractor may have a standby pump on the Site during pumping.

2. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R - Placing Concrete by Pumping Methods.

3. Pumping equipment and hose conduits that are not functioning properly, shall be replaced.

4. Aluminum conduits for conveying the concrete shall not be permitted.

3.14 TAMPING AND VIBRATING

A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted, throughout the entire depth of the layer which is being consolidated, into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required.

B. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against all surfaces. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

3.15 FINISHING CONCRETE SURFACES

A. General: Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.

B. Formed Surfaces:

1. Formed surfaces shall be treated to provide a “Smooth Form Finish”, which consists of finishing the surfaces as necessary to produce smooth, even surfaces of uniform texture and appearance, free of surface defects, depressions and other imperfections.

2. Form tie holes and defective concrete shall be repaired.

3. Where architectural finish is required, treatment(s) shall be as indicated.

4. Exposed walls shall be given a smooth finish as indicated below.

C. Unformed Surfaces: After proper and adequate vibration and tamping, unformed top surfaces of slabs, floors, walls, and curbs shall be brought to a uniform surface with suitable tools. Whenever the air temperature exceeds 85 degrees F or the wind speed exceeds 25 mph at the time of placement, the concrete shall be treated as follows. Immediately after the concrete has been screeded, it shall be treated with a liquid evaporation retardant. The retardant shall be used again after each Work operation as necessary to prevent drying shrinkage cracks. The classes of finish for unformed concrete surfaces are designated and defined as follows:

1. Finish U1 - Sufficient leveling and screeding to produce an even, uniform surface with surface irregularities not to exceed 3/8-inch. No further special finish is required.

2. Finish U2 - After sufficient stiffening of the screeded concrete, surfaces shall be float finished with wood or metal floats or with a finishing machine using float blades. Excessive floating of surfaces while the concrete is plastic and dusting of dry cement and sand on the concrete surface to absorb excess moisture will not be permitted. Floating shall be the minimum necessary to produce a surface that is free from screed marks and is uniform in texture. Surface irregularities shall not exceed 1/4-inch. Joints and edges shall be tooled where indicated or as determined by the Engineer.

3. Finish U3 - After the Finish U2 surface has hardened sufficiently to prevent excess of fine material from being drawn to the surface, steel troweling shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and produce a dense, uniform surface free from blemishes, ripples, and trowel marks. The finish shall be smooth and free of irregularities.

4. Finish U4 - Trowel the Finish U3 surface to remove local depressions or high points. In addition, the surface shall be given a light broom finish with brooming perpendicular to drainage unless otherwise indicated. The resulting surface shall be rough enough to provide a nonskid finish.

D. Unformed surfaces shall be finished according to the following schedule:

UNFORMED SURFACE FINISH SCHEDULE	
Area	**Finish**
Grade slabs and foundations to be covered with concrete or fill material	U1
Floors to be covered with grouted tile or topping grout	U2
Slabs to be covered with built-up roofing	U2

Interior slabs and floors to receive architectural finish	U3
Slabs	U4
Top surface of walls	U3

3.16 CURING AND DAMPPROOFING

A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the Work.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Construction joints between footings and walls, and between floor slab and columns	2
Encasement and ductbank concrete and thrust blocks	3
Concrete surfaces not specifically provided for elsewhere in this Paragraph	4
Buried slabs and backfilled walls	5

B. Method 1: Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used, the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 4 below.

C. Method 2: The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.

D. Method 3: The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.

E. Method 4: The surface shall be sprayed with a liquid curing compound.

1. It shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.

2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before the expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.

3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.

4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces, and within 2 hours after removal of forms. Repairs required to be made to formed surfaces shall be made within the said 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.

5. During the curing period, no traffic of any nature and no depositing of any materials, temporary or otherwise, shall be permitted on surfaces coated with curing compound. Foot traffic and the depositing of materials may be allowed after 3 Days if the surface is covered with 5/8-inch plywood placed over polyethylene sheets.

F. Method 5: This method applies to both buried slabs and walls to be backfilled.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.

2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water through nozzles that atomize the flow so that the surface is not marred or washed.

3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent being dislodged by wind or any other causes. Edges shall be continuously held in place.

4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.

5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, any dry spots shall be rewetted, and curing compound shall be immediately applied in accordance with Method 4 above.

6. The Contractor shall dispose of excess water from the curing operation to avoid damage to the Work.

7. Dampproofing: The exterior surfaces of buried roof slabs and backfilled walls shall be dampproofed as follows.

    a. Immediately after completion of curing, the surface shall be sprayed with a dampproofing agent consisting of an asphalt emulsion. Application shall be in 2 coats. The first coat shall be diluted to one-half strength by the addition of water and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon of dilute solution. The second coat shall consist of an application of the undiluted material, and shall be sprayed on so as to provide a maximum coverage rate of 100 square feet per gallon. Dampproofing material shall be as indicated above.

b. As soon as the material has taken an initial set, the entire area thus coated shall be coated with whitewash. Any formula for mixing the whitewash may be used if it produces a uniformly coated white surface and remains until placing of the backfill. If the whitewash fails to remain on the surface until the backfill is placed, the Contractor shall apply additional whitewash

G. The Contractor may submit alternate methods of curing which maintain the concrete in a continuously wet condition for acceptance by the Engineer.

3.17 PROTECTION

A. The Contractor shall protect concrete against injury until final acceptance.

B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The Contractor shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

3.18 CURING IN COLD WEATHER

A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that, during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing shall be temporarily discontinued.

B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise, the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.

C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 Days, 72 hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.

D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted by these Specifications.

3.19 TREATMENT OF SURFACE DEFECTS

A. As soon as forms are removed, exposed concrete surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the Engineer. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing extensive voids, holes, honeycombing, or similar depression defects, shall be completely removed and replaced. Repairs and replacements shall be performed promptly.

B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance or soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the suction upon which a good bond depends. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of Atlas white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. These holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross-section, and other imperfections having a depth greater than their least surface dimension, shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.

D. Repairs shall be built up and shaped in such a manner that the completed Work will conform to the requirements of this Section as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

3.20 CARE AND REPAIR OF CONCRETE

A. The Contractor shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, which becomes defective at any time prior to the final acceptance of the completed Work, which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

END OF SECTION

SECTION 03 34 00 – LOW DENSITY CONCRETE

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide Controlled Low Strength Material (CLSM), complete and in place, in accordance with the Contract Documents.

B. CLSM shall be placed where indicated and may be used, if the Engineer approves, for the following purposes:

1. Normal CLSM with high slump, non-segregating consistency that readily flows and fills voids and difficult to reach places: pipe zone fill, trench zone fill, pipe abandonment, structure backfill, and structure cavity fill.

C. Unless specifically indicated otherwise, CLSM shall be Normal CLSM.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
31 30 00	Earthwork

C. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

D. Reference Standards

ASTM International (ASTM)	
ASTM C94	Ready Mixed Concrete
ASTM C138	Unit Weight, Yield and Air Content (Gravimetric) of Concrete
ASTM C150	Portland Cement
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C403	Time of Setting of Concrete Mixtures by Penetration Resistance
ASTM C494	Chemical Admixtures for Concrete
ASTM C618	Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C803	Standard Test Method for Penetration Resistance of Hardened Concrete

ASTM D4318	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4832	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
International Code Council (ICC)	
IBC	2021 International Building Code

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Mix Designs and Testing Program:

1. Submit CLSM mix designs which show the proportions and gradations of materials proposed for each type of CLSM indicated. Each mix design shall be accompanied by independent laboratory test results of the indicated properties.

2. Submit additional correlation tests as required.

1.04 QUALITY ASSURANCE

A. Testing will be performed by a testing laboratory selected by the Owner at the Owner's expense, except as otherwise indicated.

B. If tests of the CLSM show non-compliance with the specifications, the Contractor shall make changes as may be required to achieve compliance. Performing and paying for subsequent testing to show compliance shall be the Contractor's responsibility.

C. Sampling of CLSM for compression testing shall not be less than once a day, nor less than once for each 150 cubic yards of CLSM placed each day.

1. Compression tests shall be performed in accordance with ASTM D4832.

2. Each set of specimens shall be a minimum of 5 cylinders.

3. One test cylinder shall be tested at 7 days and 2 test cylinders shall be tested at 28 days.

4. The remaining test cylinders shall be held to verify test results, if needed.

D. Additional correlation tests are required for each mix of CLSM used in pipe zone, trench zone, or backfill when CLSM is required to support traffic or other live loads on the fill less than 7 days after placing CLSM.

1. Field correlation tests shall be performed in a test pit similar in cross section to the Work and at least 10-feet long at a location near the Work. The proposed location shall be acceptable to the Engineer.

2. Laboratory and field tests shall be performed on samples taken from the same CLSM batch mix. Tests shall be performed by a laboratory at the Contractor's expense.

3. Testing shall be performed once each 2 hours during the first 8 hours, once each 8 hours during the first week, and once each 24 hours until the CLSM mix reaches the maximum design strength.

    a. Compression testing shall be in accordance with ASTM D4832. Refer to section 1.3, Quality Assurance, for testing frequency.

    b. Setting test shall be in accordance with ASTM C403.

    c. Density tests shall be in accordance with ASTM C138.

PART 2 -- PRODUCTS

2.01 CONTROLLED LOW STRENGTH MATERIAL

A. CLSM shall be a mixture of cement, pozzolan, coarse and fine aggregate, admixtures, and water, mixed in accordance with ASTM C94.

B. Composition: The following parameters shall be within the indicated limits and as necessary to produce the indicated compressive strengths.

1. Mix proportions as necessary.

2. Entrained air content shall be between 0 percent minimum and 6 percent maximum.

3. Water reducing agent content as necessary.

C. Properties

1. Density shall be between 120 PCF minimum and 145 PCF maximum.

2. Slump shall be as required by the Contractor's methods but shall not promote segregation nor shall slump exceed 9 inches.

3. Compressive strength at 28 Days:

    a. Normal CLSM: Between 100 psi minimum and 300 psi maximum.

    b. Foundation CLSM: 1,000 psi minimum.

2.02 CEMENT

A. Cement shall be Type I or II in accordance with ASTM C150.

2.03 POZZOLAN

A. Pozzolan shall be Type F or C in accordance with ASTM C618. Pozzolan content, by weight, in Normal CLSM shall not be greater than cement content,

2.04 AGGREGATE

A. Aggregate shall consist of a well graded mixture of crushed rock, soil, or sand, with a nominal maximum size of 3/8-inch. One hundred percent shall pass the 1/2-inch sieve; no more than 30 percent shall be retained on the 3/8-inch sieve; and no more than 12 percent shall pass the number 200 sieve. If more than 5 percent of the aggregate passes the number 200 sieve, the material passing the number 200 sieve shall have a plasticity index of less than 0.73 (liquid limit-20), when tested in accordance with ASTM D4318. Aggregate shall be free from organic matter and shall not contain more alkali, sulfates, or salts than the native materials at the Site.

2.05 ADMIXTURES

A. Air entraining admixtures shall be in accordance with ASTM C260.

B. Water reducing admixtures shall be in accordance with ASTM C494.

2.06 WATER

A. Water shall be potable, clean, free from objectionable quantities of silt, organic matter, alkali, salt, and other impurities.

PART 3 -- EXECUTION

3.01 PREPARATION

A. Subgrade and compacted fill to receive CLSM shall be prepared according to Section 31 30 00 – Earthwork Methods.

3.02 BATCHING, MIXING AND DELIVERY

A. Batching, mixing, and delivery of CLSM shall conform to ASTM C94. CLSM shall be mixed at a batch plant acceptable to the Engineer and shall be delivered in standard transit mix trucks.

3.03 PLACEMENT

A. CLSM shall be placed by tailgate discharge, conveyor belts, pumped, or other means. CLSM shall be directed in place by vibrator, shovel, or rod to fill crevices and pockets. Avoid over-consolidation which causes separation of aggregate sizes.

B. CLSM shall be continuously placed against fresh material unless otherwise approved by the Engineer. When new material is placed against existing CLSM, the placement area shall be free from loose and foreign material. The surface of the existing material shall be soaked a minimum of one hour before placement of fresh material, but no standing water shall be allowed when placement begins.

C. Temperature of the CLSM shall be between 50 and 90 degrees F, when placed. CLSM shall not be placed when the air temperature is below 40 degrees F. No CLSM shall be placed against frozen subgrade or other materials having temperature less than 32 degrees F.

D. CLSM shall be placed in accordance with Section 31 30 00 – Earthwork.

3.04 FINISHING

A. The finish surface shall be smooth and to the grade indicated or directed by the Engineer. Surfaces shall be free from fins, bulges, ridges, offsets, and honeycombing. Finishing by wood float, steel trowel, or similar methods is not required.

3.05 CURING

A. CLSM shall be kept damp for a minimum of 7 Days or until final backfill is placed.

3.06 PROTECTION

A. CLSM shall be protected from freezing for 72 hours after placement.

B. No fill or loading shall be placed on CLSM until probe penetration resistance, as measured in accordance with ASTM C803, exceeds 650 psi.

C. CLSM shall be protected from running water, rain, and other damage until the material has been accepted and final fill completed.

END OF SECTION

SECTION 03 60 00 – GROUTING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide grout, complete and in place, in accordance with the Contract Documents. For concrete repair material and procedures, reference Section 03 01 00 – Maintenance of Concrete.

B. Grout provided as a base support for mechanical and electrical equipment shall conform to manufacturer's requirements and the requirements of this section.

C. The following types of grout are covered in this Section:

1. Neat Cement Grout

2. Non-Shrink Grout

3. High Strength Non-Shrink Grout

4. Non-Shrink Epoxy Grout

5. Topping Grout and Grout Fill

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

C. Reference Specifications

01 33 00	Submittal Procedures
03 01 00	Maintenance of Concrete
03 30 50	Cast-in-Place Concrete
05 05 19	Post-Installed Concrete Anchors

D. Reference Standards

ASTM International (ASTM)	
ASTM C109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in Cube Specimens)
ASTM C307	Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings

ASTM C531	Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C882	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C1090	Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout
ASTM C1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1116	Standard Specification for Fiber-Reinforced Concrete
ASTM C1339	Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Grouts
International Concrete Repair Institute (ICRI)	
ICRI 310.2R-2013	Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1. Certified testing lab reports for tests indicated herein.

2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.

3. Manufacturer’s literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the Work, and location of use.

4. Documentation indicating that the grouts contain no chlorides or other chemicals that cause corrosion.

5. Manufacturer’s Safety Data Sheet documenting composition of grouts.

6. Submit manufacturer's written warranty as indicated herein.

1.04 QUALITY ASSURANCE

A. Field Tests

1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the Engineer. The specimens will be made by the Engineer or its representative.

2. Compression tests and fabrication of specimens for cement based non-shrink grout will be performed in accordance with ASTM C1107 at intervals during construction selected by the Engineer.

3. Compression tests and fabrication of specimens for topping grout and grout fill will be performed in accordance with Section 03 30 50 - Cast-in-Place Concrete at intervals during construction selected by the Engineer.

4. Compression tests and fabrication of specimens for epoxy grouts will be performed in accordance with ASTM C579, Method B, at intervals during construction selected by the Engineer. A set of 3 specimens will be made for testing at 7 days and each earlier time period as appropriate.

5. The cost of laboratory tests on grout will be paid by the Owner except where test results show the grout to be defective. In such case, the Contractor shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the Work.

6. The Contractor shall assist the Engineer in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.

B. Construction Tolerances: Construction tolerances shall be as indicated in Section 03 30 50 - Cast-in-Place Concrete unless indicated otherwise.

C. Pre-Installation Demonstration and Training

1. Non-Shrink Grouts

a. The grout manufacturer shall give a demonstration and training session for the cement based and epoxy non-shrink grouts to be used on the project before any installation of grout is allowed.

b. Training session shall use a minimum of 5 bags of cement-based non-shrink grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates to provide on-the-job training for the Contractor and Engineer. The Contractor employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.

c. The Contractor shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the Engineer.

1.05 SPECIAL CORRECTION OF DEFECTS PROVISIONS

A. Manufacturer's Warranty

1. Furnish one year warranty for Work provided under this section.

2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

PART 2 -- PRODUCTS

2.01 APPLICATION

A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Beam and column (1 or 2 story) base plates less than 16-in in the least dimension.	Non-Shrink
Column base plates (greater than 2 story or larger than 16-in in the least dimension)	High Strength Non-Shrink
Under precast concrete elements	High Strength Non-Shrink
Storage tanks and other non-motorized equipment or machinery under 30 HP	Non-Shrink
Motorized equipment over 30 HP and equipment under 30 HP but subject to severe shock loads and high vibrations	Non-Shrink Epoxy
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink
Toppings and grout fill less than 3-in thick	Topping Grout
Toppings and grout fill greater than 3-in thick	Section 2.4 and Structural Concrete per 03 30 50 - Cast-in-Place Concrete
Anchor bolts, anchor rods and reinforcing steel required to be set in epoxy or adhesive.	Post-Installed Anchors in Concrete per Section 05 05 19 - Post-Installed Concrete Anchors
Repair of holes and defects in concrete members.	Concrete Repair and Rehabilitation per Section 03 01 00 - Maintenance of Concrete

2.02 NEAT CEMENT GROUT

A. Neat cement grout shall be composed of one 94 pound bag of cement and 5 gallons minimum to 6 gallons maximum of clean water to obtain the desired consistency.

B. Cement material and water shall be as indicated in 03 30 50 - Cast-in-Place Concrete.

2.03 NON-SHRINK GROUTS

A. General

1. All non-shrink grout shall be cement based unless otherwise noted.

2. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.

3. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each non-shrink grout shall be as recommended by the manufacturer for the particular application.

4. The manufacturer’s product information shall state the acceptability of the non-shrink grout for the intended purpose and location.

5. Grout shall not contain chlorides or additives that may contribute to corrosion.

6. Grout placed in continuously wet environments or in exterior conditions shall not contain gypsum or calcium salt.

7. All cement-based non-shrink grout shall have the following general properties:

   a. Meet the requirements of ASTM C1107.

   b. Have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C827. The grout when tested shall not bleed or segregate at maximum allowed water.

   c. No shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C1090.

   d. A minimum bond strength (concrete to grout) of 1900 psi per modified ASTM C882.

8. Environmental and ambient conditions shall be a factor in the selection of non-shrink grout. If a non-shrink grout is to be used in a high temperature environment or freeze/thaw environment, the manufacturer’s product information shall state the acceptability for each environmental condition.

9. Grout shall be suitable for use in freeze/thaw environments.

B. Non-Shrink Grout

1. Non-Shrink Grout shall have a minimum 28 day compressive strength of 5000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. Non-Shrink Grout shall be Five Star Grout by Five Star Products, Inc., Fluid Grout 100 by Five Star Products, Inc., Sikagrout 212 by Sika Corporation, or approved equal.

C. High Strength Non-Shrink Grout

1. High Strength Non-Shrink Grout shall have a minimum 28 day compressive strength of 10,000 psi when mixed at a fluid consistency and tested per ASTM C109.

2. High Strength Non-Shrink Grout shall be High Strength Grout by Five Star Products, Inc., Sikagrout 428 FS by Sika Corporation, or approved equal.

2.04 NON-SHRINK EPOXY GROUT

A. Non-shrink epoxy grout shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C579, method B.

B. Non-shrink epoxy grout shall be a flowable, non-shrink, 100 percent solids system. The epoxy grout system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents.

C. The manufacturer’s product information shall state the acceptability of the epoxy grout for the intended purpose and location.

D. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.

E. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable.

F. Non-shrink epoxy grout shall have a negligible (less than 0.0006-in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested in accordance with ASTM C531.

G. The effective bearing area shall be a minimum of 85 percent effective bearing area (EBA) in accordance with ASTM C1339, for bearing area and flow.

H. The chemical formulation of the non-shrink epoxy grout shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.

I. Non-shrink epoxy grout shall have the following minimum properties when tested at 7 days:

1. Minimum bond strength to concrete of 3000 psi per ASTM C882 modified.

2. Minimum bond strength to steel of 1700 psi per ASTM C882 modified.

3. Minimum flexural strength of 2500 psi per ASTM C580.

4. Minimum tensile strength of 2000 psi per ASTM C307.

J. Non-shrink epoxy grout shall be DP Epoxy Grout by Five Star Products, Inc., MasterFlow 648 by BASF/Master Builders, Sikadur 42 Grout-Pak by Sika Corporation, or approved equal.

2.05 TOPPING GROUT AND GROUT FILL

A. Topping grout and grout fill for built-up surfaces of tanks, channels, and basin bottoms shall be composed of cement, fine aggregate, coarse aggregate, water, and admixtures proportioned and mixed as indicated. Materials and procedures indicated for structural concrete in Section 03 30 50 - Cast-in-Place Concrete, shall apply unless indicated otherwise

B. Topping grout used in clarifiers, or where the fill thickness is 3-in or greater shall contain fiber reinforcing, unless otherwise shown on the Contract Documents. Fiber reinforcing shall be 100 percent virgin polypropylene fibrillated fibers specifically manufactured in a blended gradation for use as concrete secondary reinforcement. Fibers shall be added at a rate of 1.5 lbs per cubic yard of concrete. Fibers shall conform to ASTM C1116.

C. For topping grout and grout fill thickness greater than 3-in, ready-mix concrete may be used with the following requirements:

1. Strength: Minimum compressive strength of topping grout and grout fill at 28 days shall be 4500 psi.

2. Minimum of 564 lbs of cement per cubic yard with a maximum water/cement ratio of 0.45.

3. Coarse aggregate shall be as follows:

U.S. Standard Sieve Size	**Percent By Weight Passing**
½-in	100
3/8-in	90-100
No. 4	20-55
No. 8	5-30
No. 16	0-10
No. 30	0

D. Final mix design shall be as determined by trial mix design as indicated in Section 03 30 50 - Cast-in-Place Concrete, except that drying shrinkage tests are not required.

E. Topping grout and grout fill shall contain air-entraining agent per Section 03 30 50 - Cast-in-Place Concrete.

2.06 CURING MATERIALS

A. Curing materials shall be in accordance with Section 03 30 50 - Cast-in-Place Concrete and as recommended by the manufacturer of prepackaged grouts.

2.07 CONSISTENCY

A. The consistency of grout shall be as necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is defined such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as indicated herein for the particular application.

B. The slump for topping grout and grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-in.

2.08 MEASUREMENT OF INGREDIENTS

A. Measurements shall be made accurately by volume using containers. Shovel measurements are not allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

PART 3 -- EXECUTION

3.01 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Grout shall be stored in accordance with manufacturer's recommendations.

3.02 GENERAL

A. Contractor shall arrange for the manufacturer of prepackaged grouts to provide on-site technical assistance within 72 hours of request, as part of the Work.

B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the Engineer.

C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.

D. Surface preparation, curing, and protection of cement based grout shall be in accordance with Section 03 30 50 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.

E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.

F. Shade the Work from sunlight for at least 24 hours before and 48 hours after grouting.

G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

3.03 GROUTING PROCEDURES

A. General: Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.

B. Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.

1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum 1-in thickness of grout or other thickness if indicated.

2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the Engineer, alternate grouting methods shall be submitted by the Contractor for acceptance by the Engineer.

3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-in from the edge of the pad.

C. Topping Grout and Grout Fill

1. Mechanical, electrical, and finish Work shall be completed prior to placement of topping grout or grout fill.

2. To ensure bonding to the base slab, the base slab shall have a roughened surface to a ¼-in amplitude. The base slab shall be thoroughly cleaned and wetted to saturated surface dry (SSD) condition per ICRI 310.2R-2013 prior to placing topping grout and grout fill. No topping grout shall be placed until the slab is completely free from standing pools or ponds of water. A thin coat of neat cement grout shall be broomed into the surface of the slab just before topping or fill placement. The neat cement grout shall not be allowed to dry before topping placement. If it does dry, it must be immediately removed using wet stiff brooms and reapplied.

3. The topping and fill shall be compacted by rolling or thorough tamping, brought to established grade, and floated. Grouted fill for tank and basin bottoms where scraping mechanisms are to be installed shall be screeded by blades attached to the revolving mechanism of the equipment in accordance with the procedures outlined by the equipment manufacturer after the grout is brought to the established grade. Coat surface with evaporation retardant as needed to prevent plastic shrinkage cracks.

4. The minimum thickness of grout topping and grout fill shall be 1-in. Where the finished surface of grout fill is to form an intersecting angle of less than 45 degrees with the concrete surface it is to be placed against, a key shall be formed in the concrete surface at the intersection point. The key shall be a minimum of 3 ½-in wide by 1 ½-in deep.

5. Topping grout placed on sloping slabs shall proceed uniformly from the bottom of the slab to the top, for the full width of the placement.

6. The surface shall be tested with a straight edge to detect high and low spots which shall be immediately eliminated. When the topping or fill has hardened sufficiently, it shall be steel troweled to a smooth surface free from pinholes and other imperfections. An approved type of mechanical trowel may be used as an assist in this operation, but the last pass over the surface shall be by hand-troweling. During finishing, no water, dry cement, or mixture of dry cement and sand shall be applied to the surface.

7. As soon as topping or fill finishing is completed, coat surface with curing compound. After the topping is set and sufficiently hard in clarifiers and where required by the Engineer, the tank shall be filled with sufficient water to cover the entire floor for 14 days.

3.04 CONSOLIDATION

A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

END OF SECTION

SECTION 05 05 19 – POST-INSTALLED CONCRETE ANCHORS

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide post-installed anchors and appurtenances, complete and in place, as indicated in accordance with the Contract documents.

B. Unless otherwise indicated, drilled concrete anchors shall be adhesive anchors.

C. Section Includes:

1. Adhesive anchors

2. Expansion anchors

3. Screw anchors

4. Undercut anchors (dynamic loading)

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Definitions

1. Epoxy anchors are considered to be adhesive anchors.

2. Expansion anchors, screw anchors, and undercut anchors are considered to be mechanical anchors.

C. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
03 01 00	Maintenance of Concrete
03 21 00	Reinforcement Bars
03 30 50	Cast-in-Place Concrete
05 50 00	Metal Fabrications

D. Reference Standards

1. The edition of the standards applicable to the Work shall be the edition referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

American Concrete Institute (ACI)	
ACI 318	Building Code Requirements for Structural Concrete and Commentary
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 355.2	Qualification of Post Installed Mechanical Anchors in Concrete and Commentary
ACI 355.4	Qualification for Post-Installed Adhesive Anchors in Concrete and Commentary
American Society of Civil Engineers (ASCE)	
ASCE 7	ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures
ASCE 41	ASCE/SEI 41 - Seismic Evaluation and Retrofit of Existing Buildings
International Code Council (ICC)	
IBC	International Building Code
ICC ES AC193	Mechanical Anchors in Concrete Elements
ICC ES AC308	Post Installed Adhesive Anchors in Concrete Elements
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components - Health Effects

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submit the following:

1. Product data and technical information

2. Safety Data Sheets (SDS) for adhesives

3. Manufacturer’s literature containing installation instructions and appropriate uses for each type of post-installed anchor and location of use

4. Current International Code Council Evaluation Service (ICC-ES) or International Association of Plumbing and Mechanical Officials Uniform Evaluation Service (IAPMO-UES) Evaluation Reports

5. Certification for each installer demonstrating that they have been qualified in accordance with the Quality Assurance requirements below

C. No substitution for the indicated anchors will be considered unless accompanied with an ICC-ES or IAPMO-UES report verifying strength and material equivalency.

D. Complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be completed and submitted in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1. Where adhesive anchors are used for structural applications (such as dowels between new and existing concrete) and an embedment depth is not shown on the contract documents, the anchor shall be installed in accordance with Method 1 or Method 2 below:

a. Method 1: The minimum depth of embedment shall be greater than or equal to the development length (l_d) determined in accordance with ACI 318 for a cast in place reinforcing bar of the same diameter and grade, unless it can be shown by calculation that the anchor spacing and edge distance is sufficient to develop the tensile strength of the anchor in a lesser depth of embedment.

b. Method 2: Adhesive anchors in concrete that cannot develop the tensile capacity of the steel element may be used to transfer forces, provided that:

1) For new structures, the anchor is designed in accordance with ACI 318.

2) For existing structures, the anchor is designed in accordance with ASCE 41.

1.04 QUALITY ASSURANCE

A. Special inspection for all post-installed anchor installations shall be provided:

1. As recommended or required by the ICC-ES or IAPMO-UES report.

2. As required by the enforceable building code.

3. As otherwise indicated in the Contract Documents.

B. The most stringent of the above requirements shall be used. The cost of Special Inspection of post-installed anchors shall be paid for by the Owner.

C. Before installing adhesive anchors in the Work, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading if required.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

D. Before installing mechanical anchors in the Work, anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:

1. Hole drilling procedure, hole preparation and cleaning techniques, and torquing.

2. Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.

E. Defective anchors noted by the Special Inspector shall be replaced and re-installed by the Contractor without any additional compensation.

F. Anchors installed in both the vertical and horizontal positions in a mock-up concrete panel of adequate size and thickness. Anchors shall be tested in tension using the minimum loads described below. A minimum of 3 anchors shall be tested for each installation position.

1. Anchors shall be tested at 2 times the published allowable tension load or 1-1/4 times the maximum design strength of the anchors in tension as calculated using values in the ICC-ES or IAPMO-UES report. The test load need not exceed 80 percent of the nominal yield strength of the anchor, based on steel strength, as determined by ACI 318.

2. An installer who has 3 consecutive successful anchor tests in the first or second trial is considered qualified for post-installed anchor installation for this project. The manufacturer's representative shall issue a certificate to the qualified installer, and a copy of the certificate shall be filed with the Contractor and be submitted to the Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer’s or distributor’s packaging undamaged, complete with installation instructions.

B. Protect and handle materials in accordance with manufacturer’s recommendations to prevent damage or deterioration.

C. Anchoring adhesives shall be stored at temperatures prescribed by the manufacturer and must not be used beyond the expiration date.

1.06 SITE CONDITIONS

A. Post-installed anchors shall be installed in concrete having a minimum age of 21 days at time of anchor installation.

B. The anchor or fastener coating, plating, or steel type must provide suitable corrosion resistance for the environment in which the anchor or fastener is installed. Anchors, nuts, and washers in the locations listed below shall be fabricated from type 316 stainless steel:

1. buried locations

2. submerged locations

3. locations subject to seasonal or occasional flooding

4. inside hydraulic structures below the top of the structure

5. inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

6. chemical handling areas

7. inside trenches, containment walls, and curbed areas

8. locations indicated or designated by the Engineer to be provided with stainless steel anchors.

PART 2 -- PRODUCTS

2.01 ADHESIVE ANCHORS

A. General

1. The adhesive anchor system shall consist of: 1) adhesive product; and 2) threaded rod or reinforcing bar insert. The complete system shall be compatible as required by the adhesive manufacturer.

2. Adhesives shall be injectable, two-component, cartridge-type systems dispensed and mixed through a static mixing nozzle supplied by the manufacturer.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the adhesive anchor for the intended purpose and location.

4. Adhesive anchors shall be permitted when regular ambient temperatures are consistent with manufacturer's recommendation for long and short term temperatures.

5. Adhesive anchors shall not be used where anchors are subject to vibration or fire.

6. Adhesive anchors shall not be used in overhead applications, unless specifically called out on the construction documents.

7. Where required, adhesive shall be capable of being used in submerged applications once cured.

B. Adhesive Anchors in Concrete

1. Threaded rod inserts shall meet the requirements of Section 05 50 00 - Metal Fabrications.

2. Reinforcing dowel inserts shall meet the material requirements of Section 03 21 00 – Reinforcement Bars and Section 03 30 50 – Cast-in-Place Concrete.

3. Adhesive for use in concrete adhesive anchors shall be certified for use in resisting seismic loads in cracked concrete applications in accordance with ICC-ES AC308.

4. Where not detailed on the drawings, adhesive anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC308.

5. Adhesive anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ICC-ES AC308 and ACI 355.4. Adhesive anchors to be used for structures, nonbuilding structures and/or nonstructural components assigned to Seismic Design Categories C through F shall have been tested and qualified for earthquake loading performance in cracked and uncracked concrete in accordance with ICC-ES AC308 and ACI 355.4.

6. Adhesive anchors for concrete shall be Pure110+ by Powers Fasteners, HIT-RE 500 V3 by Hilti or SET-3G by Simpson Strong-Tie, or equal.

2.02 EXPANSION ANCHORS

A. General

1. Expansion anchors are post-installed torque-controlled mechanical expansion anchors used to resist structural loads.

2. Expansion anchors shall be an imperial sized, threaded stud with an integral cone expander, expansion clip, nut and washer.

3. Lead caulking anchors will not be permitted.

4. Non-embedded buried or submerged anchors shall be fabricated from stainless steel.

5. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the expansion anchor for the intended purpose and location.

6. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Expansion Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318, which requires post-installed mechanical anchors to be qualified according to ACI 355.2.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ICC-ES AC193 and ACI 355.2. Anchors to be used for structures, nonbuilding structures and/or nonstructural components assigned to Seismic Design Categories C through F shall have been tested and qualified for earthquake loading performance in cracked and uncracked concrete in accordance with ICC-ES AC193 and ACI 355.2.

3. Expansion anchors shall be Strong-Bolt 2 by Simpson Strong-Tie, Kwik-Bolt TZ by Hilti, Power-Stud+ SD1 by Powers Fasteners, or equal.

2.03 SCREW ANCHORS

A. General

1. Screw anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

2. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the screw anchor for the intended purpose and location.

3. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

B. Screw Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ICC-ES AC193.

3. Screw anchors for concrete shall be Titen HD by Simpson Strong-Tie, Kwik HUS-EZ (KH-EZ) by Hilti, or equal.

2.04 UNDERCUT ANCHORS

A. General

1. Undercut anchors are post-installed mechanical anchors that require pre-drilling and a special undercut notch configuration cut into the concrete before installation.

2. Self-undercutting anchors are post-installed torque-controlled mechanical anchors that cut their own undercut notch by application of a setting torque that forces a sleeve over a cone.

3. The evaluation report issued by ICC-ES or IAPMO-UES shall state the acceptability of the undercut anchor for the intended purpose and location.

4. Anchors subjected to dynamic or vibratory loading shall be suitable for the intended loading and location as indicated in the manufacturer's technical product data.

5. Undercut anchors used in exterior and corrosive environments shall be fabricated from stainless steel.

B. Undercut Anchors for Concrete

1. Anchors shall be designed in accordance with ACI 318 as amended by the specific design provisions of ICC-ES AC193.

2. Anchors shall have an evaluation report issued by ICC-ES or IAPMO-UES and have been tested and qualified for performance in cracked and uncracked concrete in accordance with ACI 355.2 and ICC-ES AC193.

3. Undercut anchors for concrete shall be HDA by Hilti, Atomic+ by Powers Fasteners, or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. Post-installed anchors shall be installed in strict accordance with the manufacturer's instructions, the ICC-ES or IAPMO-UES report, and project specific design requirements indicated on the Contract Documents or in the design calculations provided by the Contractor.

B. Where holes are drilled in concrete, holes shall be accurately drilled and vertically aligned, and the holes shall be cleaned in accordance with the manufacturer’s recommendations.

C. Post-installed anchors shall not be installed until the concrete has reached the required age of 21 days or per manufacturer’s requirements, whichever is longer.

D. Acceptable installation and performance temperature ranges shall be verified with manufacturer’s literature prior to installation. Minimum substrate temperatures shall be maintained during the full curing period as required by the manufacturer.

E. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

F. The Contractor shall locate existing items and identify the position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in drilling to avoid damaging existing reinforcing or embedded items. The location of drilled holes shall be adjusted to avoid drilling through or cutting any existing reinforcing bars or embedded items. Notify the Engineer if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

G. Core drilling of holes is not allowed.

H. Bending of and welding to post installed anchors is not allowed.

I. Identification of reinforcing steel and/or embedded items, relocation of drilled holes and adjustments or modifications to anchored or fastened items shall be considered part of the Work and shall be provided at no additional cost to the Owner.

J. All abandoned drilled holes shall be repaired in accordance with Section 03 01 00 – Maintenance of Concrete at no additional cost to the Owner.

END OF SECTION

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide structural steel framing and appurtenant metal parts required for permanent connection of the structural steel system, complete and in place, in accordance with the Contract Documents.

B. The design, fabrication, and erection of structural steel elements in buildings and non-building structures, and elements thereof, shall be in accordance with the 2021 IBC, and AISC 360.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Metal Fabrications
09 96 00	High-Performance Coatings

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

C. Reference Standards

American Institute of Steel Construction (AISC)	
AISC 303	Code of Standard Practice for Steel Buildings and Bridges
AISC 341	Seismic Provisions for Structural Steel Buildings
AISC 358	Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications
AISC 360	Specification for Structural Steel Buildings
ASTM International (ASTM)	
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength

ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM F3125	Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength
American Welding Society (AWS)	
AWS B1.5	Standard for the Qualification of Welding Inspectors
AWS D1.1	Structural Welding Code – Steel
AWS D1.8	Structural Welding Code – Seismic Supplement
AWS QC1	Specification for AWS Certification of Welding Inspectors
International Code Council (ICC)	
IBC	2021 International Building Code
Research Council on Structural Connections (RCSC)	
RCSC	Specification for Structural Joints Using High-Strength Bolts

1.03 CONTRACTOR SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings, including fabrication and erection drawings for all Work, shall conform to AISC recommendations and specifications and shall show all holes, etc. required for other work. Drawings shall include complete details showing members and their connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams showing the sequence of erection.

C. Testing laboratory certifications for shop and field welders shall be submitted directly to the Engineer with copies to the Contractor and others as required.

D. Contractor's Statement of Responsibility, as required by the IBC Section 1704.4

E. Charpy V-notch impact test results for heavy section hot-rolled shapes.

F. Certifications for consumables for welding.

G. Quality Control inspection reports.

1.04 QUALITY ASSURANCE

A. Quality Assurance shall be provided as required by the IBC, AISC 360, and AISC 341.

1. Special Inspections and Tests requirements indicated in the IBC Chapter 17, and Quality Assurance requirements indicated in AISC 360 Chapter N and AISC 341 Chapter J, will be provided by and paid for by the Owner.

2. Structural Observations, if required by the Building Official or requested by the Owner, will be provided by and paid for by the Owner.

3. Contractor Responsibility requirements indicated in the IBC Chapter 17 shall be provided by and paid for by the Contractor.

B. The Contractor shall be aware of all Quality Assurance requirements, and shall provide advance notice and full access to the Owner and Engineer to conduct the inspections, tests, and observations.

1. For inspections and tests at locations away from the project site, a minimum of 14 days' notice shall be provided in writing.

2. For inspections, tests and observations at the project site, a minimum of 7 days' notice shall be provided in writing.

3. The Contractor shall provide safe access, including fall protection equipment, to all locations necessary to conduct the inspections, tests, and observations.

C. The Contractor shall supply material for testing at no cost to the Owner and shall assist the Engineer in obtaining material for test samples.

D. The Contractor shall correct or repair all defective Work. All costs associated with corrections, repairs, and retesting shall be paid for by the Contractor.

E. Refer to PART 2 for Quality Control requirements.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Structural steel

ASTM A992	Wide Flange Shapes
ASTM A572, Grade 50	Bars and Plates that are part of the following structural steel framing systems
ASTM A36	Other Shapes, Plates, Bars
ASTM A53, Type E or S, Grade B standard weight unless noted otherwise	Pipe, Pipe Columns, Bollards
ASTM A500 Grade B	HSS

B. Heavy Section Hot-Rolled Shapes

1. Hot-rolled shapes with flange thickness equal to or greater than 1 ½-in shall have a minimum Charpy V-notch toughness of 20 ft-bl at 70 deg F, tested in the alternate core location as described in ASTM A6 Supplementary Requirement S30.

C. Welds

1. Seismic Force Resisting Systems

a. Refer to Structural Drawing S-001 for the listing of seismic force resisting systems for each Facility.

b. Welds shall conform to the requirements of AISC 341 and AISC 358,

c. Welds used in members and connections in seismic force resisting systems shall be made with filler metals meeting the requirements specified in clauses 6.1, 6.2 and 6.3 of AWS D1.8.

d. Welds designated as demand critical shall be made with filler metals meeting the requirements specified in clauses 6.1, 6.2 and 6.3 of AWS D1.8.

1) The following welds are designated as demand critical:

a) Groove welds at column splices.

b) Welds at column-to-base plate connections.

c) Complete-joint-penetration groove welds of beam flanges and beam webs to columns.

2. Other filler metals and fluxes shall conform to one of the AWS specifications listed in AISC 360 Section A3.5.

D. Bolts for connections shall be ASTM F3125 Grade A325, unless indicated otherwise.

1. ASTM F3125 Grade A490 bolts shall be used where indicated.

2. Use of ASTM F3125 Grade F1852 or Grade F2280 Twist-Off/Tension-Control bolts in place of Grade A325 or Grade A490 Heavy Hex Head bolts, respectively, is subject to Engineer approval.

E. Bolts used to connect dissimilar metals shall be ASTM A193 and A194, Type 316 stainless steel.

F. Welded anchor studs shall be headed concrete anchor studs (HAS), or deformed bar anchors (DBA), or threaded studs (TAS), as indicated on the Drawings and as supplied by Nelson Stud Welding Company, Omark Industries, KSM Fastening Systems Division, or equal.

G. Structural steel shall be cleaned and coated in accordance with Section 09 96 00 – High-Performance Coatings.

H. Steel members in contact with aluminum shall be galvanized per Section 05 50 00 – Metal Fabrications, unless indicated otherwise.

I. Structural members shall be furnished full length without splices unless otherwise indicated or approved by the Engineer.

2.02 QUALITY CONTROL

A. Quality Control shall be provided as required by AISC 360 and AISC 341.

1. Quality Control requirements indicated in AISC 360 Chapter N and AISC 341 Chapter J shall be provided by and paid for by the Contractor.

PART 3 -- EXECUTION

3.01 MEASUREMENT

A. The Contractor shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of Work. The Contractor shall review the Drawings, and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.02 FABRICATION AND ERECTION

A. Structural steel shall be fabricated and erected in accordance with the Drawings, AISC Specifications, AWS Standards, and the Shop Drawings.

B. Materials shall be properly marked and match-marked for field assembly.

C. Where finishing is required, assembly shall be completed including bolting and welding of units, before start of finishing operations.

3.03 BOLTED CONSTRUCTION

A. The Contractor shall comply with the requirements of the AISC and RCSC specifications applicable to bolted connections.

B. Surfaces for slip-critical connections shall be prepared in accordance with RCSC specifications.

3.04 WELDED CONSTRUCTION

A. The Contractor shall comply with the AISC specifications, AWS D1.1 and AWS D1.8 for procedures, appearance, and quality of welds and welders, and methods used in correcting Defective Work. Welded architectural metal that is exposed to view shall have welds ground smooth. Shielded metal arc welding method or gas metal arc welding methods shall be used for welding structural steel.

B. Unless otherwise indicated, butt and bevel welds shall be complete penetration.

3.05 HOLES FOR OTHER WORK

A. Holes shall be provided as necessary or as indicated for securing other Work to structural steel framing, and for the passage of other Work through steel framing members. No torch cut holes will be permitted.

3.06 SHOP PAINT PRIMER

A. Shop paint primer shall be applied in accordance with Section 09 96 00 – High-Performance Coatings. Omit shop-applied primer at field weld locations, for the portion of a member to be embedded in concrete, and where galvanizing with no further coating is required.

3.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being excessively stressed, deformed, or otherwise damaged.

B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. Repair or replace damaged materials or structures as directed.

3.08 ERECTION

A. The Contractor shall comply with the AISC Specifications and Code of Standard Practice, and with indicated requirements.

B. High-strength bolts shall be installed in accordance with the RCSC Specification. The connections shall be the slip-critical, unless indicated otherwise.

C. Anchor rods and other connectors required for securing structural steel to in-place Work and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the Contractor.

D. The Contractor shall be responsible for designing and installing any temporary bracing required for the safe erection of structural steel members.

3.09 SETTING BASES AND BEARING PLATES

A. Prior to the placement of non-shrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of all bond-reducing materials, and concrete and masonry bearing surface shall also be cleaned of all bond-reducing materials and be roughened to improve bonding.

B. Loose and attached baseplates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

C. Anchor rods shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its indicated strength.

D. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

3.10 FIELD ASSEMBLY

A. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastening. Bearing surfaces and other surfaces that will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

B. Individual members of the structure shall be leveled and plumbed within AISC tolerances.

C. Required leveling and plumbing measurements shall be established on the mean operating temperature of the structure.

3.11 MISFITS AT BOLTED CONNECTIONS

A. Where misfits in bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

B. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

C. Correction of misfits is part of the Work.

3.12 GAS CUTTING

A. Gas cutting torches shall not be used in the field for correcting fabrication errors in the structural framing, except when approved by the Engineer. Gas-cut sections shall be finished equal to a sheared appearance.

3.13 TOUCH-UP PAINTING

A. Immediately after erection, field welds, bolted connections, and abraded areas shall be cleaned of the shop paint primer. Touch-up paint primer applied by brush or spray shall be the same thickness and material as used for the shop coat. Galvanized surfaces that have been field welded or damaged shall be repaired in accordance with Section 05 50 00 - Metal Fabrications.

B. Finish coating of structural steel shall be as indicated in Section 09 96 00 – High-Performance Coatings.

END OF SECTION

SECTION 05 30 00 – METAL DECKING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide steel decking and accessory items, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Metal Fabrications
05 12 00	Structural Steel Framing
09 96 00.10	High-Performance Coatings

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

C. Reference Standards

American Iron and Steel Institute (AISI)	
AISI S100	North American Specifications for the Design of Cold - Formed Steel Structural Members
ASTM International (ASTM)	
ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvanealed) by the Hot-Dip Process
American Welding Society (AWS)	
AWS D1.3	Structural Welding Code-Sheet Steel
International Association of Plumbing and Mechanical Officials (IAPMO)	
IAPMO-UES	Evaluation Reports for each type of steel decking used in the Work
International Code Council (ICC)	
ICC-ES	Evaluation Reports for each type of steel decking used in the Work
Steel Deck Institute (SDI)	
SDI C	Standard for Composite Steel Floor Deck - Slabs
SDI RD	Standard for Steel Roof Deck
SDI NC	Standard for Noncomposite Steel Floor Deck
SDI QA/QC	Standard for Quality Control and Quality Assurance for Installation of Steel Deck

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Prior to the commencement of any Work, the Contractor shall submit an affidavit furnished by the deck manufacturer certifying the yield strength, gauge and section properties, and diaphragm shear values for the steel deck using the welding pattern and/or shear capacity indicated. Failure to conform to this requirement shall be justification for rejection of the material.

C. Submit a layout drawing showing the location of deck sheets, end laps, side laps, types and locations of welds and details of accessories.

D. Submit an ICC-ES or IAPMO-UES Evaluation Report for each type of steel decking used in the Work.

1.04 QUALITY ASSURANCE

A. No insulation, roofing materials, or other permanent coverings shall be placed over the decking until the Engineer has inspected it for placement, welds, and accessories. Stored materials and debris shall be removed to facilitate the inspection. Welds found to be defective shall be replaced as a part of the Work.

1.05 MATERIAL STORAGE

A. Decking stored at the Site before installation shall be stacked on the ground on platforms or pallets and be covered with tarpaulins or other weatherproof covering.

PART 2 -- PRODUCTS

2.01 STEEL DECK

A. Unless indicated otherwise, steel deck shall be manufactured from steel conforming to ASTM A653 having a minimum yield strength of 50,000 psi.

B. The steel deck structural properties shall be as indicated. The moment of inertia and section modulus of the steel deck unit shall be computed in accordance with the SDI specifications, and in accordance with AISI S100.

C. Steel decking shall be galvanized and shall conform to ASTM A 653 and to the applicable requirements of Section 05 50 00 – Metal Fabrications. Steel deck shall be free of oil, grease, and dirt before dipping.

D. Steel deck shall be finished in accordance with Section 09 96 00.10 – High-Performance Coatings. Deck shall be free of oil, grease and dirt before coating application.

E. The steel deck shall have sheet length that covers 3 or more spans.

F. The steel deck sheets shall be formed at the longitudinal sides in such a manner that they will overlap and/or interlock. Where the end of sheets overlap, they shall be die-formed in such a manner that the sheet in the next row telescopes and snugly overlaps the sheet laid previously.

G. Plates needed to connect decking to supports or to maintain deck continuity shall be 14-gauge galvanized sheet.

H. Structural steel shapes, including angles and inserts, shall be in accordance with Section 05 12 00 - Structural Steel Framing.

2.02 MANUFACTURERS

A. The steel decking shall be manufactured by Verco Manufacturing Company, ASC Pacific Inc., Vulcraft Nucor Corporation Inc., or equal.

PART 3 -- EXECUTION

3.01 INSTALLATION REQUIREMENTS

A. The Contractor shall inspect supporting members for correct layout and alignment, and shall not proceed with installation until defects are corrected and supporting members are completely installed and secured.

B. Steel deck sheets and accessories shall be placed in accordance with the manufacturer's recommendations and the Shop Drawings. Roofs having a slope of ¼-in per foot or more shall be installed starting at the low side, to ensure that end laps are shingle fashion.

C. Steel deck sheets shall be positioned on supporting steel framework and adjusted to final position with ends bearing a minimum of 2-in on supporting members. Units shall be placed end to end, with ribs aligned over the entire length of the run before being permanently fastened.

D. Special care shall be exercised not to damage or overload the deck during installation. The deck shall not be used for storage or as working platforms until permanently secured in position. Construction loads shall not exceed the deck carrying capacity, as recommended by the manufacturer.

E. Openings in the deck shall be cut and fitted neatly and shall be reinforced with structural steel members to distribute the load.

F. Where concrete fill is required, deck shall be installed with closure plates and other accessories as needed to prevent loss of water, cement, and fines during placing and consolidation of the concrete.

G. Edges of any cut openings or any minor surface damage areas shall be repaired in accordance with applicable requirements of the Section 09 96 00 – High-Performance Coatings and Section 05 50 00 – Metal Fabrications.

H. After installation, surfaces shall be cleaned and left free of grime and dirt. The Contractor shall remove unused materials, tools, scaffolding, and debris from the premises and leave the area broom clean.

3.02 WELDING

A. Care shall be exercised in the selection of electrodes and amperage to provide positive welds and to prevent high amperage blowholes. Welds shall be made from the top side of the deck immediately after alignment.

B. The steel deck shall be welded to supporting members with ½-in effective diameter puddle welds spaced at 12-in on center at members parallel to the ribs and at every rib valley at members perpendicular to the ribs, unless otherwise indicated. Welding washers shall be used when welding steel deck of less than 0.028-in thickness. Welding washers shall not be used when welding steel deck of 0.028-in or greater.

C. Side laps shall be welded with 1-1/2-in long top seam welds, spaced at 12-in on center unless indicated otherwise.

D. Welds shall be free of sharp points or edges. Welds shall be cleaned immediately by chipping or wire brushing and shall be coated with a zinc dust type primer paint.

E. Welding shall conform to the applicable requirements of AISI S100 and AWS D1.3. Welders shall be AWS certified.

END OF SECTION

SECTION 05 50 00 – METAL FABRICATIONS

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Referenced Specifications

01 33 00	Submittal Procedures
03 60 00	Grouting
05 05 19	Post-Installed Concrete Anchors
09 96 00.10	High-Performance Coatings

C. References herein to "Building Code" shall mean the 2021 International Building Code (IBC). The edition of the standards applicable to the Work shall be those editions referenced by the IBC. If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of award of this contract.

Aluminum Association (AA)	
AA DAF-45	Designation System for Aluminum Finishes
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO	LRFD Bridge Design Specifications
American Institute of Steel Construction (AISC)	
AISC	Steel Construction Manual
AISC	Detailing for Steel Construction
American Iron and Steel Institute (AISI)	
AISI S100	North American Specification for the Design of Cold - Formed Steel Structural Members
ASTM International (ASTM)	
ASTM A36	Standard Specification for Carbon Structural Steel
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A193	Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A780	Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM A1085	Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM C478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C497	Standard Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile
ASTM D4101	Standard Classification System and Basis for Specification for Polypropylene Injection and Extrusion Materials
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125	Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength
American Welding Society (AWS)	
AWS B1.5	Standard for the Qualification of Welding Inspectors
AWS D1.1	Structural Welding Code – Steel
AWS D1.2	Structural Welding Code - Aluminum
AWS D1.3	Structural Welding Code - Sheet Steel
AWS D1.6	Structural Welding Code – Stainless Steel
AWS D1.8	Structural Welding Code-Seismic Supplement
AWS QC1	Qualification and Certification of Welding Inspectors
International Code Council (ICC)	
IBC	2021 International Building Code

Military Specification (MIL)	
MIL-G-18015 A (3)	(Ships) Aluminum Planks. (6063-T6)
MIL-PRF-907F	Antiseize Thread Compound, High Temperature
National Association of Architectural Metal Manufacturers (NAAMM)	
NAAMM MBG531	Metal Bar Grating Manual
NAAMM MBG532	Heavy Duty Metal Bar Grating Manual
Steel Deck Institute (SDI)	
SDI RD	Standard for Steel Roof Deck
SDI NC	Standard for Noncomposite Steel Floor Deck
SDI QA/QC	Standard for Quality Control and Quality Assurance for Installation of Steel Deck
United States Department of Labor - Occupational Safety and Health Administration (OSHA)	
OSHA 1910.23(d)	Fixed Ladders
OSHA 1910.29	Fall Protection Systems And Falling Object Protection-Criteria and Practices

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Shop Drawings shall conform to AISC Detailing for Steel Construction, and shall show all holes, material grades, and location of parts/pieces in the completed Work.

2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.

C. Grating

1. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.

2. Submit load and deflection tables for each style and depth of grating used.

D. Anchor Submittals

1. For post installed anchors in concrete other than powder-driven pins or impact anchors, refer to Section 05 05 19 – Post-Installed Concrete Anchors.

2. For cast-in-place anchors, powder-driven pins or impact anchors, complete structural calculations and anchorage details shall be prepared and submitted by the Contractor for all anchors and anchor groups that are shown but not completely detailed (type, size, location, spacing and embedment) on the Contract Documents. Calculations and anchorage details shall be signed and stamped by a Professional Engineer registered in the state in which the project is located.

E. Aluminum Railing Submittals

1. Shop Drawings: Include railing layouts, post locations, and spacings, gate locations, removable railing sections, connectors, construction details, manufacturer's engineering data, installation instructions, product data, and any deviation requests.

2. Calculations: Engineering structural calculations for railings, handrail brackets, other brackets, support flanges, and fasteners or anchors.

1.04 QUALITY ASSURANCE

A. Weld procedures and welder qualifications shall be available in the Contractor’s field office for review.

B. Welding Special Inspection shall be performed by the Owner in accordance with the enforceable Building Code.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Steel

Wide Flange Shapes	ASTM A992
Shapes, Plates, Bars	ASTM A36 unless indicated otherwise
Pipe, Pipe Columns, Bollards	ASTM A53, Type E or S, Grade B standard weight unless indicated otherwise
HSS	ASTM A500 Grade B, ASTM A1085

B. Corrosion Protection

1. Unless otherwise indicated, fabricated steel metalwork which will be used in a corrosive environment and/or will be submerged in water or wastewater shall be coated in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings, and shall not be galvanized prior to coating.

2. Other miscellaneous steel metalwork shall be hot-dip galvanized after fabrication. Weight of galvanizing shall be G90 unless noted otherwise.

C. Stainless Steel

1. Unless otherwise indicated, stainless steel metalwork and bolts shall be fabricated from Type 316 stainless steel.

2. Where anaerobic conditions are noted, Type 304 stainless steel shall be used.

D. Aluminum

1. Unless otherwise indicated, aluminum metalwork shall be fabricated from Alloy 6061-T6.

2. Aluminum in contact with concrete, masonry, wood, porous materials, or dissimilar metals shall have contact surfaces coated in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

E. Cast Iron

1. Unless otherwise indicated, iron castings shall conform to the requirements of ASTM A48, Class 50B, or better.

2.02 ALUMINUM RAILINGS

A. General

1. Aluminum handrails and railings shall be component systems, complete with anchors, attachments, balusters, brackets, caps, fasteners, gates (swing with self-latching hardware or be removable), posts, sleeves, trim, and any other related items as required or necessary for a complete installation.

2. Gates and removable rail sections shall be complete with hardware such as self-closing hinges, self-latching latches, hasps, and the like.

3. Railings shall conform to Building Code and OSHA requirements, General Industry Occupational Safety and Health Standards (29CFR1910).

B. Materials shall conform to the following requirements:

1. Aluminum

a. Aluminum shall be U.S. Alloy 6061-T6, 6063-T5 or T6, or 6005-T5.

b. Aluminum pipe rail shall not be less than 1-1/2-in diameter Schedule 40 pipe.

2. Electrolysis protective material shall be in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

3. Sleeves for embedment into concrete shall be PVC.

4. Grout for handrail posts shall consist of an inorganic, non-shrink, non-metallic premixed grout in accordance with the requirements of Section 03 60 00 - Grouting.

5. Fasteners, screws, and bolts shall be concealed and shall be fabricated from stainless steel or aluminum.

6. Aluminum welding rods shall be of a type recommended by the aluminum manufacturer for anodized finished products.

7. Kickplates shall be provided on railings and not set in curbs.

C. Pipe railing systems, including handrails, railings, tube caps, and other miscellaneous parts of the rails, shall be provided with a clear anodized finish, AA-M32C22A41.

D. Manufacturers or Equal

1. C-V Pipe Rail by Crane Veyor Corp.

2. Connectorail by Julius Blum and Co.

3. Handrail Systems, Inc.

2.03 STEEL PIPE HANDRAILS

A. Steel pipe handrails, including brackets and related hardware which may be partially or wholly submerged or which are located inside a hydraulic structure, shall be fabricated entirely of Type 304 stainless steel.

B. Other steel pipe handrails shall be standard 1-1/2-in black steel pipe made up by welding, and shall be hot-dip galvanized after fabrication.

2.04 METAL STAIRS

A. Metal Stairs

1. Metal stairs shall be composed of steel or aluminum stringers and supports, shall be fabricated in accordance with the standard practice of the National Association of Ornamental Metal Manufacturers, and shall be as indicated.

2. Steel stair members shall be hot-dip galvanized after fabrication.

2.05 GRATING STAIR TREADS

A. Grating stair treads shall be designed to support a distributed live load of 100 psf or a concentrated live load at mid-span of 300 pounds, whichever creates the higher stress.

B. The maximum deflection due to the uniform live load shall be as required for metal grating, below.

C. Grating stair treads shall be provided with an integral non-slip nosing.

2.06 SAFETY STAIR NOSINGS

A. Safety stair nosing shall be provided on concrete stairs, steel pan stairs, and other locations as indicated.

B. The nosing shall be 3-in wide and fabricated from extruded aluminum with cast-in abrasive strips and integral extruded anchors.

C. The color of the cast abrasive shall be as selected by the Engineer from among the manufacturer's standard colors.

D. The nosing shall be Amstep Products Style 231-A, Grating Pacific XRS-3, Robertson Grating Products Type 9511, or equal.

2.07 RECESSED FLOOR GRID

A. The floor grid shall consist of single- or multi-tread extrusions interlocked together to form finished mat sections.

B. Tread rails shall be fabricated from aluminum, spaced 1-1/2-in on-center, and shall run counter to the traffic flow.

C. The floor grid shall be designed for a minimum 300 psf uniform load.

D. The floor grid shall be removable and replaceable without requiring disassembly of the entire grid and without damage to the grid.

E. Frame

1. The recessed frame shall be of a cast-in type, with anchors spaced at a minimum of 24-in on-center.

2. The frame shall be fabricated from aluminum and where in contact with concrete shall be coated in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

F. Tread Surface

1. The tread surface shall be composed of a continuous crosshatched vinyl insert.

2. The color of the inserts shall be as selected by the Engineer from among the manufacturer's full range of custom colors.

G. The floor grid shall be Balco, Inc. FG or FG3 Series, Perfec Grate 456 by Reese Enterprises, or equal.

2.08 LADDERS

A. Materials

1. Ladders which may be partially or wholly submerged or which are located inside a hydraulic structure shall be fabricated entirely of Type 316 stainless steel, unless indicated otherwise.

2. Other ladders shall be fabricated from aluminum, unless noted otherwise.

B. Fixed Step-Through Ladders shall be equipped with grab bar extensions meeting OSHA requirements.

1. Approved products include Model 504 Access Ladder by O'Keefe's, or equal. Grab bars by CAI Safety Systems may be added to other existing or new ladders.

C. Ladder Safety System

1. The ladder safety system at each ladder shall include a carrier rung, ladder ring clamps, 2 sleeves and full body harnesses, dismount section, and other components as necessary for a complete system.

2. The carrier rail shall be fabricated from the same material as the ladder, except for fiberglass ladders, which shall be provided with stainless steel carrier, rails, and shall be the length recommended by the manufacturer for the ladder dimensions, including extensions.

3. All requirements of OSHA 1910.29 must be met.

4. The system shall be stainless steel unless noted otherwise. When steel ladders are specified, the ladder safety system is permitted to be galvanized steel.

5. The ladder safety system shall be Lad-Saf by DBI Sala, Climb Rite by Sellstrom Manufacturing Company, Saf-T-Climb by Honeywell Miller, or equal or equal.

D. Pop-Up Extension

1. Every ladder that does not extend above the access level shall be equipped with a pop-up ladder extension.

2. The pop-up ladder extension device shall be manufactured of the same material and finish as the ladder, and shall be provided with a telescoping tubular section that locks automatically when fully extended.

3. Upward and downward movement shall be controlled by stainless steel spring balancing mechanisms.

4. The units shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.

2.09 METAL GRATING

A. General

1. Metal grating shall be of the indicated design, size, and type.

2. Grating shall be supported around an opening by support members.

3. Where grating is supported on concrete, provide embedded support angles, unless otherwise indicated. Support angles shall match the grating material and mitered and welded at their corners.

4. Banding

a. The grating shall be completely banded at edges and cutouts.

b. The banding material and cross-section thickness shall be equivalent to the bearing bars.

c. The banding shall be welded to each cut bearing bar.

5. The grating pieces shall be fastened to each support by positive means in 2 locations.

6. Where grating forms the landing at the top of a stairway, the edge of the grating that forms the top riser shall have an integral non-slip nosing with a width equal to that of the stairway.

7. Where the grating depth is not indicated, provide grating within allowable stress levels and which shall not exceed a deflection of ¼-in or the span divided by 180, whichever is less.

8. Design Loading

    a. For standard duty plank and safety grating, unless otherwise indicated, the loading to be used for determining stresses and deflections shall be the uniform live load of the adjacent floor or 100 psf, whichever is greater, or a concentrated load of 1000 pounds.

    b. For heavy duty grating, the loading used for determining stresses and deflections shall be in accordance with AASHTO HL-93.

B. Standard Duty Grating

1. Except where indicated otherwise, bar grating shall be fabricated entirely of:

    a. aluminum

        1) Bearing and Banding Bars: Alloy 6061-T6

        2) Cross Bars: Alloy 6063-T5

    b. galvanized steel

2. Safety grating shall be fabricated from aluminum alloy 5052-H32.

3. Plank grating shall be fabricated from aluminum alloy 6063-T6.

4. Grating that may be partially or wholly submerged shall be fabricated entirely of Type 316 stainless steel

5. No single piece of grating shall weigh more than 80 pounds, unless indicated otherwise.

6. Standard duty grating shall be composed of serrated bar grating.

7. Cross bars shall be welded or mechanically locked tightly into position such that there is no movement between the bearing and cross bars.

C. Safety Grating

1. Safety grating shall be fabricated from sheet metal punched into an open serrated diamond pattern and be formed into plank sections.

2. The open diamond shapes shall be approximately 1-7/8-in by 11/16-in in size.

3. Safety grating shall be Grip Strut by Metal Products Division, United States Gypsum Company, Deck Span by IKG Industries, or equal.

D. Heavy-Duty Grating

1. Heavy-duty grating shall be fabricated from welded steel, galvanized after fabrication.

2. Crossbars shall be welded in position.

3. Banding bars shall have a minimum thickness of ¼-in.

E. Plank Grating

1. Plank grating shall be extruded in 6-in widths with a minimum of 6 integral one-bar type bearing bars per plank.

2. The top surface shall be solid with raised ribs, unless indicated otherwise.

3. Where punched grating is required, the top surface shall be provided with a pattern of 3-in by 19/32-in rectangular openings spaced at 4-in on-center.

4. The planks shall have a continuous tongue-and-groove type interlock at each side, except that interlocking planks shall be arranged such that any 4-ft wide section may be removed independently from the other grating sections.

2.10 CHECKERED PLATE

A. Checkered plate shall be provided with a pattern of raised lugs on one face and shall be smooth on the opposite face.

B. Lugs

1. Lugs shall be a minimum of 1-in in length and raised a maximum of ½-in above the surface.

2. The lugs shall be located in a pattern in which the lugs are oriented at 90 degrees from the adjacent lugs in 2 orthogonal directions.

3. The rows of lugs shall be oriented at 45 degrees from the edges of the plates.

C. Where no material is indicated, the plates shall be fabricated from aluminum.

D. Unless indicated otherwise, the minimum plate thickness shall be as required to limit deflection resulting from a live load of 100 psf to ¼-in, or the span divided by 240, whichever is less.

2.11 HATCHES - GENERAL

A. Configuration

1. Hatch opening sizes, number and swing direction of door leaves, and locations shall be as indicated.

2. Indicated sizes are for the clear opening.

3. Where the number of leaves is not indicated, openings larger than 42-in in either direction shall be provided with double-leaf doors.

4. Unless indicated otherwise, hinges shall be located on the longer dimension side.

5. Unless indicated otherwise, ladder hatches shall be a minimum of 30-in wide by 36-in long, with the ladder centered on the shorter dimension and the door hinge opposite the ladder.

B. Hatches shall be provided with an automatic hold-open arm with release handle.

C. Hatches shall be designed for easy opening from both inside and outside.

D. Hatches shall be provided with a recessed hasp for a padlock covered by a hinged lid that is flush with the surface.

E. Safety Grates

1. Unless indicated otherwise, hatch safety grates conforming to OSHA requirements shall be provided.

F. Nets

1. Unless indicated otherwise, hatch nets shall be provided on floor hatches.

2. Hatch nets shall conform to OSHA requirements.

3. Hatch nets shall be Hatch Net 121, as manufactured by Safe Approach, Inc, Auburn, ME, or equal.

2.12 ALUMINUM HATCHES

A. Hatches shall be fabricated from aluminum 5086 H34, 6063-T5 or 6061-T6, unless otherwise indicated.

B. Hatch hardware shall be fabricated from Type 316 stainless steel.

C. Hatches shall be flush-type.

D. The design live load shall be 300 PSF, unless indicated otherwise.

E. Door leaves shall be fabricated from a minimum of 1/4-in thick checkered-pattern plate.

F. Channel frames shall be fabricated from a minimum 1/4-in material with an anchor flange around the perimeter.

G. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter, a moat-type edge drain, and drain piping of the length and size necessary to remove the drain water from all dry spaces accessed by the hatch.

H. A minimum 1-1/2-in diameter drain connection shall be provided, located by the manufacturer.

I. Hatches shall be provided with a recessed hasp for a padlock covered by a hinged lid that is flush with the surface.

J. Hatches shall be EJ Co. Type CHS, Bilco Type J or JD, Babcock-Davis Type B-FGA, or equal.

2.13 DUCTILE IRON HATCHES

A. Hatches, including all appurtenant components, shall be intended for use in roadways and trafficways, and shall be specifically designed to resist frequent impact from heavy vehicle loads.

B. Hatches shall be fabricated from ductile iron.

C. Hatches shall have an integrated lift-assist mechanism.

D. Hatch hardware shall be fabricated from Type 316 stainless steel.

E. Hatches shall be bottom flange mount type.

F. The design live load shall be the maximum load from the AASHTO HL-93 vehicle, unless otherwise indicated.

G. Door hinges shall be concealed, and shall be designed to accommodate easy removal of the doors.

H. Hatch doors shall have an integral gasket.

I. Hatches shall include an integral recessed lock, EJ EON Lock, or equal

J. Hatches shall be Series 8198 by EJ Co., or equal.

2.14 STAINLESS STEEL HATCHES

A. Hatches shall be fabricated from Type 316 stainless steel.

B. Hatch hardware shall be fabricated from Type 316 stainless steel.

C. The design live load shall be 300 PSF, unless indicated otherwise.

D. Door leaves shall be fabricated from a minimum of 1/4-in thick checkered-pattern plate.

E. Channel frames shall be fabricated from a minimum 1/4-in material with an anchor flange around the perimeter.

F. Hatches shall be designed to be water-tight and shall be equipped with a joint gutter, a moat-type edge drain, and drain piping of the length and size necessary to remove the drain water from all dry spaces accessed by the hatch.

G. A minimum 1-1/2-in diameter drain connection shall be provided, located by the manufacturer.

2.15 STEEL DECKING

A. Steel decking shall be of the indicated size and gauge, and shall meet the requirements of SDI.

B. The steel shall be hot-dip galvanized after fabrication in accordance with ASTM A653 OR ASTM A924 to G90.

2.16 IRON CASTINGS

A. General

1. Iron castings shall be of uniform quality, free from blowholes, porosity, hard spots, shrinkage, distortion, or other defects.

2. The castings shall be smooth and well cleaned by shotblasting.

3. Covers and grates shall fit together evenly, such that the cover fits flush with the surrounding finished surface and such that the cover does not rock or rattle when a loading is applied.

4. Round covers and frames shall be provided with machined bearing surfaces.

B. Covers and grates with matching frames shall be designed to support the following loadings:

1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is indicated, a minimum of 300 pounds per square foot.

2. Exterior covers and grates shall be designed for the maximum loading from the AASHTO HL-93 vehicle unless indicated otherwise.

2.17 MANHOLE RUNGS

A. Rungs shall meet ASTM C 478 and the following requirements:

1. Rungs shall be spaced not less than 10-in apart nor more than 14-in apart, as measured between centerlines of the rungs.

2. Rungs shall be parallel, level, and uniformly spaced.

3. The rungs shall be shaped such that a person's foot cannot slide off the end of the rung.

4. Rungs shall be surfaced to prevent injury from punctures or lacerations, and to prevent snagging of clothing.

5. The minimum perpendicular clearance between rungs and any obstruction behind the ladder shall be 6-in.

6. The minimum width of rungs shall be 14-in.

B. Submit certified test results in accordance with ASTM C 497, for the following loads:

1. The horizontal pull-out load shall be 400 pounds.

2. The vertical load shall be 800 pounds.

C. Material

1. Rungs shall be fabricated from co-polymer polypropylene that encapsulates a minimum ½-in grade 60 steel reinforcing rod.

2. The co-polymer polypropylene shall meet ASTM D4101, Type PP200B33430.

2.18 BOLTS AND ANCHORS

A. Standard Service (Non-Corrosive Application)

1. Bolts, anchor rods, anchor bolts, washers, and nuts shall be fabricated from steel as indicated.

2. Threads on galvanized bolts, rods and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.

3. Except as otherwise indicated, steel for bolt material, anchor rods, anchor bolts, and cap screws shall be in accordance with the following requirements:

a. Structural Connections: ASTM A307, Grade A or B, hot-dip galvanized.

b. Headed Anchor Rods and Anchor Bolts: ASTM F1554, Grade 36, hot-dip or mechanically galvanized with Grade A matching nuts.

c. High-Strength Bolts, where indicated: ASTM F3125, Grade A325.

d. Pipe and Equipment Flange Bolts: ASTM A193, Grade B7.

B. Corrosive Service

1. Bolts, anchor rods, anchor bolts, nuts, and washers in the locations listed below shall be fabricated from stainless steel as indicated.

a. buried locations

b. submerged locations

c. locations subject to seasonal or occasional flooding

d. inside hydraulic structures below the top of the structure

e. inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump

f. chemical handling areas

g. inside trenches, containment walls, and curbed areas

h. locations indicated or designated by the Engineer to be provided with stainless steel bolts

C. Stainless steel bolts, nuts, anchor rods, and washers shall be of Type 316 stainless steel, with bronze nuts, or cap screws (where screwed into stainless steel), of copper-silicon alloy, conforming to ASTM B 98, alloy C 65100, designation H04, or alloy C 65500, designation H04. Wherever stainless steel bolts and nuts are indicated, it shall refer to the above material combination, unless specifically excluded.

D. Coating

1. Threads on stainless steel bolts and rods shall be protected with an antiseize lubricant suitable for submerged stainless steel bolts, meeting government specification MIL-A-907E.

2. Buried bolts in poorly drained soil shall be coated the same as the buried pipe.

3. Antiseize lubricant shall be classified as acceptable for potable water use by the NSF.

4. Antiseize lubricant shall be "PURE WHITE" by Anti-Seize Technology, Franklin Park, IL, 60131, AS-470 by Dixon Ticonderoga Company, Lakehurst, NJ, 08733, or equal.

E. Bolt Requirements

1. The bolt and nut material shall be free-cutting steel.

2. The nuts shall be capable of developing the full strength of the bolts.

3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.

4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.

5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.

6. Lock washers fabricated from material matching the bolts shall be installed where indicated.

7. The length of each bolt shall be such that the bolt extends at least 1/8-in beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

2.19 POWDER-ACTUATED PINS

A. Powder-actuated pins for installation in concrete or steel shall be fabricated from heat-treated steel alloy.

B. If the pins are not inherently sufficiently corrosion-resistant for the conditions to which they will be exposed, they shall be protected in an acceptable manner.

C. Pins shall have capped or threaded heads capable of transmitting the loads the shanks are required to support.

D. Pins that are connected to steel shall be provided with longitudinal serrations around the circumference of the shank.

2.20 IMPACT ANCHOR

A. Impact anchors shall be an expansion-type anchor in which a nail-type pin is driven to produce the expansive force.

B. The pin shall be provided with a zinc sleeve with a mushroom-style head and stainless steel nail pin.

C. Anchors shall be Zinc Nailon Anchors, manufactured by Simpson Strong-Tie, Inc., Metal Hit Anchors, manufactured by Hilti, Inc., Rawl Zamac Nailin, manufactured by the Rawlplug Company, or equal.

PART 3 -- EXECUTION

3.01 FABRICATION AND INSTALLATION REQUIREMENTS

A. Fabrication and Erection: Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

B. Aluminum Railings

1. Aluminum railing fabrication and installation shall be performed by craftsmen experienced in the fabrication of architectural metalwork.

2. Exposed surfaces shall be free from defects or other surface blemishes.

3. Dimensions and conditions shall be verified in the field.

4. Joints, junctions, miters, and butting sections shall be precision fitted with no gaps occurring between sections, and with surfaces flush and aligned.

5. Electrolysis protection of materials shall be provided.

C. Unless otherwise indicated, provide a ½-in drain line to the nearest floor drain for floor hatches.

D. Powder-Actuated Pins

1. Powder-actuated pins shall be installed by a craftsperson certified by the manufacturer as being qualified to install the manufacturer's pins.

2. Pins shall be driven in one initial movement by an instantaneous force that has been carefully selected to attain the required penetration.

3. Driven pins shall conform to the following requirements where "D" is equal to the pin shank diameter:

Material Penetrated by Pin	**Material Minimum Thickness**	**Pin Shank Penetration in Supporting Material**	**Minimum Space From Pin's CL to Edge of Penetrated Material**	**Minimum Pin Spacing**
Concrete	16D	6D minimum	14D	20D
Steel	1/4-in	Steel thickness	4D	7D

3.02 WELDING

A. Method

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.

2. The qualification of the welders shall be in accordance with the AWS Standards.

B. Quality

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.

2. Weld reinforcement shall be as indicated by the AWS Code.

3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.

4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.

5. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-in on the flat.

3.03 GALVANIZING

A. Structural steel plates shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A123.

B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.

C. Bolts, anchor rods, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.

D. Field Repairs

1. Galvanizing shall be repaired in accordance with ASTM A780.

2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4-in into the undamaged area.

3. The coating shall be applied to at least 3 mils dry film thickness, and shall be Zinc-Clad XI by Sherwin-Williams, Galvax by Alvin Products, Galvite by ZRC Worldwide, or equal.

3.04 LADDER SAFETY SYSTEM

A. A ladder safety system shall be provided on all ladders, unless indicated otherwise. Install ladder safety systems on ladders in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 06 20 00 – FINISH CARPENTRY

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide finish carpentry and appurtenant Work, complete, in place, and operational in accordance with the Contract Documents.

B. The Contractor shall coordinate color samples with other Sections through the submittal process, as required by the Engineer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

Architectural Woodwork Quality Standards Illustrated (AWI)	
ASTM International (ASTM)	
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
Commercial Standard	
CS 236-66	Strength and Stiffness Properties of Particleboards
National Electrical Manufacturers Association (NEMA)	
NEMA LD3	High Pressure Decorative Laminates

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

1. Manufacturer's color charts for color selection by the Owner.

C. Warranty: Submit a copy of the warranty.

D. Certifications:

1. Certification by the finish carpentry Manufacturer that the finish carpentry materials are suitable for, and compatible with, the required installation.

2. Certification that the finish carpentry provided complies with the requirements indicated.

3. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and Owner.

4. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and Owner.

E. Shop Drawings: Complete Shop Drawings showing location and detail of installation.

1. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each casework countertop, and cabinet type, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim.

2. Shop Drawings shall show installation conditions at adjacent construction, and shall include indications for anchorage devices, blocking, backing, and reinforcement built into other Work for securing finish carpentry.

F. Samples: The Contractor shall submit 2 Samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show thicknesses, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1. Manufacturer's plastic laminate color samples.

2. Counter construction – Plastic laminate surface on both sides with required edge condition and backsplash, full counter thickness by 12-in by 12in.

3. Cabinet casework – Plastic laminate on both sides of a jointed bottom and side Section and a door Section hinged to side showing flush overlay. Provide a 12-in cube section.

4. Cabinet casework hardware – submit samples of all hardware components.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Cabinet, countertop, and casework shall be provided from a single Manufacturer.

B. Manufacturer Qualifications:

1. Cabinet, countertop, and casework Manufacturer shall have a minimum of 10 years of cabinet, countertop, and casework manufacturing experience.

2. Cabinet, countertop, and casework manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

C. Installer Qualifications:

1. A minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

D. For finish carpentry items, comply with the specified provisions of the "Architectural Woodwork Quality Standards Illustrated" of the AWI Premium Grade Standards.

1.05 SPECIAL WARRANTY PROVISIONS

A. Furnish manufacturer's 5 year written warranty to cover defects in materials, products and manufacturing workmanship.

B. The Contractor shall furnish separate, but concurrently running, 5 year written warranty to cover labor.

C. Warranties shall be non-prorated for the entire warranty period.

D. The term of the warranties shall begin on the date of substantial completion.

PART 2 -- PRODUCTS

2.01 CABINET, COUNTERTOP, AND CASEWORK CORE MATERIAL

A. Description: Core material for plastic laminate Work shall be 45 lb density, industrial grade particle board conforming to Commercial Standard CS 236-66: Type 1, Grade B, Class 2, and ¾-in minimum thickness as recommended in writing by the laminate Manufacturer.

2.02 PLASTIC LAMINATE

A. Approved Manufacturers:

1. Subject to the requirements herein, provide products from one of the Manufacturers listed below.

a. Formica High Pressure Plastic Laminates

b. Wilsonart International Plastic Laminates

c. Panolam Surface Systems

B. Description:

1. Plastic laminate shall comply with NEMA Publication LD3 for general purpose type 0.050-in minimum thickness for exposed Work and 0.020-in minimum thickness for back-up sheets as required.

2. Finish shall be matte texture.

3. Performance Standards:

ASTM E 84	Flame Spread: 25 or less Smoke Developed: 450 or less

C. Color shall be selected and approved by the Owner from the Manufacturer's full color range.

1. Tentative color selection: Provide for 3 color choices to be selected.

2. The Owner reserves the option of changing this tentative color selection during the submittal process.

2.03 CABINET HARDWARE

A. Manufacturer, or Equal:

1. Subject to the requirements herein, provide products from the Manufacturer listed below, or equal.

a. Sugatsune America, Inc.

B. Description:

1. Door and drawer pulls shall be Type 316 stainless steel, satin finish, with stainless steel screws, Sugatsune America Model No. SWF-650.

2. Stainless steel hinges, spring loaded, European Style, for ¾-in thick overlay doors, Sugatsune America Model No. 436-C46/19.

C. All drawers shall have medium duty side-mounted, cold rolled steel, zinc plated roller slides with ball bearings, by **Grass America, Inc**., or equal.

D. Shelf standards for cabinets shall be chrome plated steel, end-of-shelf supports with integral doweled ends to fit drilled holes in cabinet sides.

E. Countertop Grommet Assemblies for Wiring – **Dar/Ran** or equal, 1 ¾-in diameter cast metal caps with ½-in wide wire space and caps locking into body of grommet, also in metal. Assemblies shall be flush with tops.

1. Provide in color selected by the Owner.

2.04 FABRICATION

A. The Contractor shall field verify size, location, and placement of finish carpentry, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

B. Finish carpentry shall be fabricated to be rigid, neat in appearance, and free from defects, including warping, cupping, or other defects. Finish carpentry shall be accurately manufactured to required sizes and profiles.

C. Plastic laminate Work and components shall comply with AWI Section 400, Premium Grade. Provide laminate on cabinet interiors, on both sides of exposed shelves, and other exposed Work. Provide plastic self-edges. Provide balancing and backup sheets as required in AWI Section 400, Premium Grade.

D. Finish Carpentry shall be fabricated to conform to the intent of the elevations, sections, and details shown.

E. Cabinet casework shall be flush overlay design.

F. Finished Work shall be dressed and sanded, free from machine and tool marks, abrasions, raised grain, or other defects on surfaces exposed to view.

G. Optimum Moisture Content for shop and site fabricated Work shall be as follows: Kiln dry solid wood to the average moisture content of 8 percent as recommended by AWI Section 100 G-3. Maintain optimum moisture content until final finish has been applied.

H. Work shall be continuous in lengths for the size of finish carpentry indicated. No splicing will be allowed.

I. Install cabinet hardware where indicated or as required for a complete installation.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Secure loose components from damage during delivery. If such items are to be delivered separately from main body of casework, wrap each piece separately to protect finish and clearly mark to show proper location in completed casework.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer’s written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer’s written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where finish carpentry will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed finish carpentry.

2. The Contractor shall notify in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with references, with the requirements of the CODE, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

C. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, with no distortions and allowing for required movement, including expansion and contraction.

D. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

E. Install finish carpentry in a manner consistent with quality of specified Grade.

F. Shim and secure to structure with concealed shims and fasteners as required for complete installation. Scribe and cut for accurate fit to other Work as required.

3.05 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking, which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, finish carpentry and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, as determined by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the cabinet doors, drawers, and other moving parts.

1. Moving parts shall operate smoothly, quietly, and without squeaking and binding.

2. The Contractor shall make adjustments required and retest until accepted.

D. Finish carpentry shall be protected from damage from subsequent construction operations.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

1. Remove and replace defective Work, including finish carpentry that is warped, bowed, or otherwise unacceptable.

G. When finish carpentry Work is completed, remove unused materials, containers, and equipment, and clean the Site of finish carpentry debris.

END OF SECTION

SECTION 06 80 00 – FIBER GLASS REINFORCED PLASTIC FABRICATIONS

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide fabricated fiberglass reinforced plastic (FRP) items, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Metal Fabrications

C. Reference Standards

1. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

ASTM International (ASTM)	
ASTM D570	Standard Test Method for Water Absorption of Plastics
ASTM D635	Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D 696	Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between −30°C and 30°C with a Vitreous Silica Dilatometer
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2344	Standard Test Method for Short-Beam Strength of Polymer Matrix Composite Materials and Their Laminates
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
American Water Works Association (AWWA)	
AWWA F101	Contact Molded, Fiberglass-Reinforced Plastic Wash Water Troughs and Launders
AWWA F102	Matched-Die-Molded, Fiberglass-Reinforced Plastic Wier Plates, Scum Baffles and Mounting Brackets
International Code Council (ICC)	

IBC	2021 International Building Code
NSF International (NSF)	
NSF 61	NSF/ANSI/CAN 61: Drinking Water System Components – Health Effects
Office of Safety and Health Administration (OSHA)	
OSHA 1910	Occupational Safety and Health Standards

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures

B. Shop Drawings: Shop Drawings for every FRP item. Include plans, elevations, and profiles that clearly show material sizes, types, styles, part or catalog numbers. Drawings shall include complete details for the fabrication and erection of components, including location, dimensions, lengths, joining method, type and size of fasteners, clip angles, member sizes, and connection details.

C. Layout drawings for grating shall show the direction of span, type and depth of grating, size and shape of grating panels, seat angle details, and details of grating hold down fasteners.

D. Product Literature: Manufacturer's published literature including structural design data, structural properties, and load and deflection tables for each style and depth of grating, corrosion resistance tables, certificates of compliance, test reports (as applicable), anchoring system allowable load tables and ICBO reports.

E. Calculations: Structural calculations shall be submitted for stairs, stair support systems, handrails, railing systems, brackets, support flanges, ladders, and fasteners or anchors. Calculations shall be signed and sealed by a professional engineer registered in the State of Washington.

F. Samples: Samples of each type of product shall be submitted if requested by the Engineer.

G. Certification: The Contractor shall certify on the Shop Drawings that items and fabrications have been manufactured of materials suitable for potable water usage per NSF 61, and that fabricated items are of sufficient strength to serve their intended function without undue distortion or deflection.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Items provided under this Section shall be furnished only by manufacturers having experience in the manufacture of similar products, with a record of 5 similar successful installations in the last 5 years.

B. Quality: Fiberglass items shall be constructed of new, first-class, commercial-quality, fiberglass fabric-reinforced polyester or vinyl ester resin laminate material of the strength, thickness, and dimensions indicated, using the matched die-molded method.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. FRP items shall be composed of fiberglass reinforcement and resin in quantities, qualities, properties, arrangements, and dimensions as necessary to meet the design requirements and dimensions indicated.

B. Fiberglass reinforcement shall be continuous roving, continuous strand mat, and surfacing veil or a combination thereof in sufficient quantities for the application and physical properties required.

C. Unless indicated otherwise, resin shall be fire retardant isophthalic polyester or vinyl ester with chemical formulation as necessary to provide the corrosion resistance, strength, and other physical properties as required. FRP items used in chemical storage or containment areas shall be vinyl ester resin, with chemical formulations as necessary to provide the corrosion resistance, strength, and other physical properties required in those areas.

D. Finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids, and without dry spots, cracks, crazes, or unreinforced areas. Glass fibers shall be well covered with resin to protect against exposure from wear or weathering.

E. Resin shall include an ultraviolet (UV) inhibitor additive. FRP products located in exterior locations exposed to the weather or in UV facilities shall also have an additional 1 mil UV-resistant coating applied.

F. FRP products shall have a tested flame spread rating of 25 or less per ASTM E84 - Surface Burning Characteristics of Building Materials. Gratings and stair treads shall also meet the self-extinguishing requirements of ASTM D635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

G. Supports and Fasteners: The Contractor shall provide bolts, anchor bolts, nuts, washers, and supports as required for the Work of this Section in accordance with the requirements of the manufacturers of the items. Bolts, anchor bolts, washers, and supports shall be Type 316 stainless steel. Concrete anchor systems shall be in accordance with Section 05 50 00 – Metal Fabrications.

H. Cut or machined edges, holes, scratches, gouges, and abrasions shall be sealed with a resin compatible with the resin matrix used in the original item.

2.02 FIBERGLASS TROUGHS

A. Scope of Work: Fiberglass troughs shall be provided complete with weir plates, gates, connecting hardware, and other accessories to provide a fully functional installation. Each trough shall have a semi-circular bottom. Fiberglass troughs shall conform to AWWA F101 - Contact-Molded, Fiberglass-Reinforced Plastic Wash Water Troughs and Launders, except where more stringent requirements are indicated in this Section.

B. Construction: The minimum trough wall thickness shall be ¼-in. Troughs shall be reinforced with suitable stiffeners integrally molded as needed. The top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8-in, measured when the trough is not loaded. The length of a trough section shall have a tolerance of plus or minus 1/8-in per 10 ft of length. The laminate thickness tolerance shall be plus 1/8-in, minus zero.

C. Color: Troughs shall be constructed with an integral blue-green color. Up to 4 percent by weight of thixotropic agent may be added to the polyester resin as required to prevent runoff.

D. The troughs shall be provided with integral support saddles and anchor bolts to connect them to the support beams indicated.

E. Troughs shall be designed to support the following loadings within stress and deflection limitations.

1. Gravity Load: Downward vertical loads shall include the weight of the trough and appurtenant attachments such as weir plates, gates, spreader bars, etc. together with the weight of water to fill the trough. Any additional loads, such as piping, etc., shall also be considered.

2. Buoyant Load: The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected) with gates, where provided, in a closed position.

3. Lateral Load: These loads are defined as loads acting against the side walls that are induced by differential water levels on either side of the walls. The trough shall be designed assuming an empty trough with water level at the maximum possible elevation outside the trough and assuming the trough filled to maximum possible water depth while there is no water outside the trough.

4. The troughs shall be designed to accommodate temperature-induced stresses resulting from differences in coefficients of thermal expansion and contraction between the trough and the supporting material. The troughs shall be designed to accommodate a thermally induced expansion or contraction of 1/8-in per 20 ft of trough length over a temperature range from minus 10 deg F to 100 deg F without exceeding the deflection or stress limitations herein.

5. The trough system shall be designed to resist torsional oscillations induced by the flow of water over the trough edges and wave action within the tank. Any or all of the following trough stabilization techniques shall be considered:

    a. Trough to trough stabilization

    b. Torsional stiffness

    c. Internal baffles and/or flow straighteners

6. Lateral supports across the top width of the trough shall be provided at each support point and elsewhere as needed.

7. Deflection under load

    a. Maximum vertical deflection under full buoyant or gravity load shall not exceed the unsupported trough length divided by 1000. Under no circumstances shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16-in.

b. Maximum trough sidewall horizontal deflection under full lateral load shall not exceed the trough depth divided by 100. Under no circumstances shall the maximum side wall deflection exceed 3/16-in.

c. Trough bottom deflection (oilcanning) under full buoyant or gravity load shall not exceed the trough width divided by 100. Under no circumstances shall the maximum bottom deflection exceed 3/16-in.

F. Mechanical and Physical Properties

Ultimate tensile strength (minimum)	12,000 psi	ASTM D638
Flexural strength (minimum)	19,000 psi	ASTM D790
Flexural modulus of elasticity (minimum)	900,000 psi	ASTM D790

G. Troughs shall be as manufactured by F.B. Leopold Company, Warminster Fiberglass Company, or equal.

2.03 ADJUSTABLE FIBERGLASS WEIR PLATES

A. Construction: Adjustable fiberglass weir plates shall be fabricated to the dimensions indicated, with ¼-in minimum thickness and of an integral blue-green color. Weir plates shall be provided with oversized holes for adjustment as indicated. Cut or ground edges shall be resealed. Necessary accessories required to complete the installation shall be provided. Fiberglass weir plates shall conform to AWWA F102 - Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates, Scum Baffles, and Mounting Brackets, except where more stringent requirements are required by this Section.

B. Physical Properties: Minimum physical properties shall be as follows:

Tensile strength	7,500 psi	ASTM D638
Flexural strength	16,000 psi	ASTM D790
Coefficient of thermal expansion (average)	16 x 10^{-6} inch per inch length per F degree	ASTM D696
Water absorption in 24 hours	Less than 0.2 percent	ASTM D570

C. Weirs shall be as manufactured by F.B. Leopold Company, Warminster Fiberglass Company, or equal.

2.04 FIBERGLASS GRATING

A. General

1. Seat Angles: Where grating is supported on concrete members, continuous embedded seat angles shall be provided on all sides. Grating seat angles shall be made of FRP and be as detailed on the Drawings; except that specially manufactured pultruded FRP seat angles intended to be cast in concrete may be submitted for acceptance by the Engineer.

2. Load/Deflection Requirements: Grating shall be capable of spanning the distances indicated with a minimum safety factor of 3 for stresses and without exceeding a deflection equal to the lesser of ¼-in or the span divided by 180. The loading used for determining stresses and deflections shall be the uniform live load of the adjacent floor area or 150 pounds per square foot, whichever is greater, or a concentrated load of 1000 lbs at the center of the span, unless otherwise indicated.

3. Color: The color of the grating and seat angles shall match. The color shall be high visibility safety yellow. gray. as selected by the Engineer. The color selected shall result in no additional cost to the Owner.

4. The top surface of grating shall be provided with a non-slip surface by embedding or bonding grit to the FRP.

5. Penetrations: Cutouts shall be provided were needed for penetrations through the grating. The grating shall be reinforced where necessary to meet the load/deflection requirements despite the cutouts.

6. Dimensional Requirements: When grating is designed to span primarily in one direction, the grating shall be fabricated to span in the shorter span direction, unless indicated otherwise. Individual pieces of grating shall not exceed 80 lbs in weight, unless indicated otherwise.

7. Mechanical grating clips shall be manufactured of Type 316 stainless steel. Grating hold-down clips shall be provided, spaced at a maximum of 4 ft apart or as recommended by the manufacturer, whichever is less. A minimum of 4 clips per piece of grating is required.

2.05 MOLDED FRP GRATING

A. Molded FRP grating shall be of a one piece molded construction with tops and bottoms of bearing bars and cross bars in the same plane. Grating shall have a square mesh pattern rectangular mesh pattern .

B. Gratings shall be reinforced with continuous rovings of equal number of layers in each direction to provide bidirectional load bearing.

C. Non-slip surfacing: Grating shall have a concave profile grit on the top of each bar for maximum slip resistance.

D. Molded FRP grating shall be Fibergrate by Fibergrate Composite Structures, Inc., Corgrate Molded Fiberglass Grating by IKG Industries, Duragrate by Strongwell; or equal.

2.06 PULTRUDED FRP GRATING

A. Pultruded FRP grating shall be fabricated from bearing bars and cross rods manufactured by the pultrusion process. The glass fiber reinforcement for the bearing bars shall have a core of continuous glass strand rovings wrapped with a continuous strand glass mat. The outermost layer covering shall be a surface veil to provide a resin-rich surface. Bearing bars shall be interlocked and chemically bonded into place to provide a panel that resists twist forces and prevents internal movement of the bearing bars.

B. Pultruded FRP grating shall be Safe-T-Span by Fibergrate Composite Structures, Inc.; Corgrate by IKG Industries; Duradek by Strongwell; or equal

2.07 SOLID FRP GRATING

A. Where solid fiberglass grating is indicated, it shall provide a continuous, solid surface and shall meet the requirements for FRP grating except as modified herein.

B. The FRP plate shall be designed to span with integral stiffening elements or may be cast with or continuously bonded to FRP grating to act as a unit to carry the required loads.

C. Hold-down fasteners shall be countersunk screws or otherwise detailed so as to be flush with the top surface. Where countersunk screws are used, the minimum plate thickness at the screw shall be 3/8-in.

D. Fiberglass grating shall be by Strongwell, Fibergrate Composite Structures, IKG Industries, or equal.

2.08 FRP STAIR TREADS

A. Stair treads shall be of a one-piece molded construction reinforced with continuous rovings.

B. Non-slip surfacing: Stair treads shall be manufactured with either a concave profile on the top of each bar or shall have grit bonded or embedded to provide maximum slip resistance. For additional safety and to meet OSHA requirements, stair treads shall be manufactured with a minimum 1 ½-in molded nosing. Nosing shall be bonded with angular grit.

C. Load/Deflection Criterion: Stair treads shall be within allowable stress levels and shall not exceed a deflection of ¼-in or the span divided by 180, whichever is less. The loading to be used for determining stresses and deflections shall be a uniform live load of 150 psf or a concentrated load of 300 lbs at the center of the span.

D. Hardware: Type 316 stainless steel hold-down clips shall be provided, spaced as recommended by the manufacturer. A minimum of four hold-down clips shall be required for each tread.

E. FRP stair treads shall be Fibertred by Fibergrate Composite Structures, Inc., Molded Cortreads by IKG Industries, Duradek Stair Treads by Strongwell, or equal.

2.09 RAILINGS

A. Posts and rails shall be structural shapes manufactured by the pultrusion process.

B. Handrails that are used in industrial-commercial, non-public areas shall be a 3 rail system with equal open spaces between rails and toeboard with no open space larger than 12-in as required by OSHA.

C. Handrails that are used in public areas shall be a picket rail system with pickets spaced not more than 4-in on center. Pickets shall be not less than ¾-in square. Toe board of picket rails shall function as a bottom rail enclosure.

D. Posts shall be not less than 2-in square for square systems or 1.9-in diameter for round rail systems. Rails and railings shall be not less than 1 ½-in square for square rail systems or 1.9-in diameter for round rail systems and shall be provided with bottom enclosures. Top railings shall be as long as possible and the posts shall not project through the top rails.

E. The minimum mechanical properties for structural shapes used in the handrail shall be as required for structural shapes below.

F. Color: Rails, posts, and kick plates shall be integrally pigmented yellow gray .

G. Loading Conditions: Railings and handrail brackets shall be capable of withstanding the following non-simultaneous loading conditions without exceeding the allowable working stress of the material and without permanent deformation, with a minimum factor of safety on loading of 2.0.

1. A 200 lb concentrated load applied to any point in any direction

2. A 50 lb per linear ft loading applied perpendicular to the top rail.

H. The post/rail connection shall be fabricated such that the rails are unbroken and continuous through the post without the use of packs or splices. Exposed post corners shall be radiused to eliminate sharp edges. The rails shall be joined to the post through a combination of bonding and mechanical fastening. No sharp or protruding edges shall remain after assembly of the railing. Spacing of the posts shall not exceed 5 ft for straight runs or 4 ft for inclined runs.

I. The base of the posts shall be reinforced to a minimum height of 1-in above the uppermost bolthole.

J. Full posts shall be located not more than 18-in from horizontal or vertical change in railing direction.

K. Hardware: Fasteners in the railing system shall be Type 316 stainless steel.

L. FRP handrail shall be Dynarail by Fibergrate Composite Structures, Inc., Corgrip by IKG Industries, Safrail by Strongwell, or equal.

2.10 LADDERS AND CAGES

A. Ladder side rails, rungs, ladder mounting brackets, and cage straps shall be FRP structural shapes manufactured by the pultrusion process. The minimum mechanical properties for structural shapes used in ladders and cages shall be as required for structural shapes below. Cage hoops and brackets shall be produced by the open molded hand lay-up method.

B. Wall brackets connecting the ladder to the wall shall be spaced at a maximum of 6 ft on centers.

C. Rungs shall penetrate the wall of the tube side rails and shall be connected to the rails with both chemical and mechanical fastenings.

D. Non-slip surfacing: Ladder rungs shall be provided with either continuous flutes around the rung or a quartz grit integrally molded into the top surface of the rung.

E. Color: Ladder and cage components shall be integrally pigmented yellow. Wall and floor mount brackets shall be gray.

F. Loading Criterion: The completed ladder and cage installation shall meet the load requirements as set forth in OSHA 1910 (latest edition) with a minimum factor of safety on loading of 2.0. The ladder shall also be capable of supporting an ultimate concentrated vertical load of 1,200 lb applied at the mid-span of the rung. The ladder manufacturer shall be required to provide supporting test data for rung capacity.

G. FRP ladders and cages shall be Dynarail Ladders by Fibergrate Composite Structures, Inc., FRP Ladders by IKG Industries, Safrail Ladder and Cages by Strongwell, or equal.

2.11 STRUCTURAL SHAPES

A. Structural shapes shall be manufactured by the pultrusion process and have a maximum of 55 percent and a minimum of 45 percent glass content (by weight).

B. Pultruded structural shapes are to have the minimum longitudinal mechanical properties listed below:

Property	ASTM Method	Minimum Value	Units
Tensile Stress (Lengthwise)	D638	30,000	psi
Tensile Modulus (Lengthwise)	D638	2.5×10^6	psi
Flexural Stress (Lengthwise)	D790	30,000	psi
Flexural Modulus (Lengthwise)	D790	1.6×10^6	psi
Short Beam Shear (Lengthwise)	D2344	4,500	psi
Shear Modulus (Lengthwise)	N/A	4.2×10^5	psi
Coefficient of Thermal Expansion (Lengthwise)	D696	4.4×10^{-6}	in/in/deg F

C. FRP structural shapes shall be Dynaform Fiberglass Structural Shapes by Fibergrate Composite Structures, Inc, Extren by Strongwell, CorLight by IKG Fiberglass Systems, or equal.

PART 3 -- EXECUTION

3.01 PRODUCT DELIVERY AND STORAGE

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins, catalysts, and hardeners shall be crated or boxed separately.

B. Storage of Products: Materials shall be carefully handled to protect them from abrasion, cracking, chipping, twisting, deformations, and other types of damage. Store items in an enclosed area and free from contact with soil and water. Store adhesives, resins, catalysts, and hardeners in dry indoor storage facilities between 70 and 85 deg F. There shall be labels on the outside of the boxes indicating that the products shall be stored as described above.

3.02 GENERAL

A. FRP products shall meet the dimensional requirements and tolerances indicated. The Contractor shall verify measurements and determine correct size and locations of required holes or cutouts from field dimensions before fabrication.

B. FRP products shall be fabricated free from warps, twists, or other defects that affect appearance and serviceability.

C. The Contractor shall give ample notice prior to the beginning of any fabrication work so that the Engineer can perform shop inspections.

D. The Contractor shall install FRP structures in accordance with the manufacturer’s assembly drawings. Field cut and drill FRP products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer’s instructions. Follow manufacturer’s instructions when cutting or drilling fiberglass products or using resin products.

E. Bonding of FRP items shall be through the use of an epoxy adhesive recommended by the manufacturer of the particular item. The surfaces to be bonded shall be solvent cleaned and abraded sufficiently to remove the surface gloss and to remove any mold release agent or other contaminants which may interfere with proper bonding. The adhesive manufacturer's instructions and recommendations shall be followed. The items bonded shall not be stressed until at least 48 hours have passed.

3.03 GRATING

A. Layout: Each grating section shall be readily removable except where indicated. As much as possible, manufacturer shall provide openings and holes where indicated on the Contract Drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

1. Install the grating with a minimum 1.5-in bearing surface at the support ends.

2. Tolerances between sections shall provide for not more than 1/4-in clearance between adjacent sections or between grating and frames. Adjacent sections shall line up to form an uninterrupted straight line where possible.

3. The grating shall be as free, as commercially possible from visual defects such as foreign inclusions, delamination, blisters, resin burns, air bubbles, and pits. The surface shall have a smooth finish (except for non-slip surfaces).

4. Seat angles shall be mitered and bonded at corners to produce smooth, even, level seating surface.

5. Grating shall be installed so that the top surface is level and even with adjacent walking surfaces. There shall be no protrusions above the top surface.

6. Grating shall be fastened to supports.

3.04 LADDERS AND CAGES

A. Ladders shall be fully shop assembled. Ladder cages shall be test assembled and drilled to ensure a proper fit in the field. Ladder cage brackets shall remain attached to the ladder for shipping, but ladder cage components can be disassembled, packaged, and shipped separately to prevent damage in transit. Cage components shall be bundled with each respective ladder.

3.05 WEIR PLATES

A. Weir plates shall be installed plumb and level, free of warp or twist, within plus or minus 1/8-in over the length of the weir.

3.06 TROUGHS

A. Troughs shall be installed so that the trough weir edges are level to within plus or minus 1/8-in over the length of the trough.

B. The connection of the trough to the wall at the discharge end shall be watertight.

C. Anchor bolts shall be located a minimum of 3-in from the edge of concrete wall openings or support beams.

3.07 RAILINGS

A. Component Systems

1. Unless otherwise indicated, handrails and railings shall be component systems, complete and ready for use with anchors, attachments, pickets, brackets, caps, fasteners, gates, posts, sleeves, trim, and all other related items required or necessary for the complete installation.

2. Installation instructions, splice fasteners, and adhesive shall be included in each shipment. Handrails shall have cut edges sealed. The handrail will be shipped pre-fabricated, requiring only post, kick plate, and rail splicing.

B. Workmanship: Work shall be performed by craftsmen experienced in the fabrication of structural fiberglass items. Exposed surfaces shall be free from defects or other surface blemishes. Dimensions and conditions shall be verified in the field in advance. Joints, junctions, miters, and butting sections shall be precision-fitted, with no gaps occurring between sections, and surfaces shall be flush and aligned.

C. Alignment: Pultruded, case-molded, or bent work shall be straight and with true edges. Railings and handrails shall be provided with continuous top rails, without post projections or other obstructions.

D. Expansion/Contractions: Exterior railing systems shall provide for 1/4-in expansion and contraction per 20 linear ft of railing. Interior railing systems shall provide for 1/8-in expansion or contraction per 20 linear ft of railing.

E. Railing Continuity and End Treatment: Handrails and railings shall be designed to form a continuous run system with elbow turns and bends that do not interfere with hand movement. Handrails shall be continuous for the full length of the stairs and landings. Handrails shall extend not less than 12-in beyond the top and bottom risers. Ends of handrails shall be returned to wall or shall be terminated in newel posts or safety terminals. Newel posts and safety terminals may be used only when approved by the Engineer.

F. Gates and Removable Sections

1. Gates shall be provided with self-closing hinges and self-closing latch bolts. Removable handrail sections shall be provided where indicated. The gate and removable railing hardware color shall match that of the railing system of which it is a part.

2. Railing posts installed into sleeves shall be provided with weep holes for condensation drainage.

3.08 STRUCTURAL SHAPES

A. Measurement: The Contractor shall verify dimensions, making any field measurements necessary, and shall be fully responsible for accuracy and layout of Work. The Contractor shall review the Drawings, and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

B. Fabrication

1. Structural FRP shall be fabricated in accordance with the Drawings and as indicated on the Shop Drawings.

2. Materials shall be properly marked and match-marked for field assembly.

3. Where finishing is required, assembly shall be completed including bolting before starting of finishing operations.

C. Connections: Shop and field connections shall be bonded and bolted as indicated. Unless indicated otherwise, connections shall develop full strength of members joined.

D. Holes for other Work: Holes shall be provided as necessary or as indicated for securing other Work to FRP framing, and for the passage of other Work through FRP members. Threaded nuts shall be epoxied to framing, and other specialty items as indicated to receive other Work. Field cuts and drilled edges shall be sealed with a resin compatible with the original resin and recommended by the manufacturer. The sealing of the edges shall prevent premature fraying at the field cut edges.

E. Erection

1. Anchor bolts and other connectors required for securing structural FRP to in-place Work and templates and other devices for presetting bolts and other anchors to accurate locations shall be furnished by the Contractor.

2. The Contractor shall be responsible for designing and installing any temporary bracing required for the safe erection of all structural FRP members.

F. Setting bases and bearing plates

1. Prior to the placement of nonshrink grout beneath base and bearing plates, the bottom surface of the plates shall be cleaned of bond-reducing materials. Concrete and masonry bearing surface shall also be cleaned of bond-reducing materials and be roughened to improve bonding.

2. Loose and attached base plates and bearing plates for structural members shall be set on wedges, leveling nuts, or other adjustable devices.

3. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the nonshrink grout has attained its required strength.

4. Base plates shall be grouted with nonshrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.

G. Field Assembly

1. Structural frames shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanent fastening. Bearing surfaces and other surfaces that will be in permanent contact shall be cleaned before assembly. Necessary adjustments to compensate for discrepancies in elevations and alignments shall be performed.

2. Individual members of the structure shall be leveled and plumbed within required tolerances. The Contractor shall provide and install all temporary bracing required until structure is complete.

H. Misfits at Bolted Connections

1. Where misfits in bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated. Methods of remedy may include, but are not limited to the following:

   a. Reaming holes that must be enlarged to admit oversized bolts.

   b. Drilling additional holes in the connection, to conform to manufacturer's standards for bolt spacing, end, and edge distances, and adding additional bolts.

   c. Rejecting the improperly fabricated member and fabricating a new member to ensure proper fit.

2. Mis-sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins.

3. The Contractor shall pay costs associated with the repair of misfits.

END OF SECTION

SECTION 07 11 00 – DAMPPROOFING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Dampproofing

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures
07 21 13	Board Insulation

D. Reference Standards

American Society for Testing and Materials (ASTM)	
ASTM D 1187	Asphalt-Base Emulsions for Use as Protective Coatings for Metal
ASTM D 1227	Emulsified Asphalt Used as a Protective Coating for Roofing

1.03 SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certificates

1. Certification by the dampproofing Manufacturer that the dampproofing provided is suitable for, and compatible with, the required installation.

2. Certification by the dampproofing Manufacturer that the products supplied comply with local regulations controlling the use of volatile organic compounds (VOCs).

3. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and Owner.

4. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and Owner.

C. Application Schedule

1. Furnish a detailed and complete application schedule indicating location and detail of installation.

D. Samples

1. When requested by Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve Contractor from compliance with the Contract Documents.

1.05 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers

a. Minimum of 10 years of dampproofing manufacturing experience.

b. Minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers

a. Minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

B. Manufacturer's Technical Field Representative

1. The Contractor shall arrange for a Manufacturer's technical field representative to be on Site for at least 3 days, beginning at the start of surface preparation and continuing through application, to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

1.06 WARRANTY

A. Manufacturer Warranty

1. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Special Warranty

1. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

C. Warranty Provisions

1. Warranties shall be non-prorated for the entire warranty period.

2. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 DAMPROOFING

A. Dampproofing shall be suitable for, and compatible with, the insulation provided under Section 07 21 13 – Board Insulation.

B. Manufacturer and Product, or Equal:

1. MasterSeal 615 by Master Builders Solutions, including primer as recommended by Manufacturer.

C. Performance Requirements

1. Cold-applied water-based emulsified-asphalt dampproofing and vapor-retarding coating for concrete and concrete block foundation and cavity wall applications, suitable for installation on "green" or slightly damp surfaces.

2. Shall be reinforced with short fibers for application by brush or spray.

3. Dampproofing shall comply with ASTM D 1227, Type 2, Class I, and ASTM D 1187, Type 1.

2.02 PROTECTION BOARD

A. Provide dampproofing manufacturer's recommended protection board, which shall be compatible with dampproofing.

B. Description: Protection board shall be suitable for the protection of dampproofing from damage during backfill operations, as recommended in writing by the dampproofing manufacturer.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Dampproofing shall be installed on exterior face of foundation walls from top of footing, up to 2-in below finish grade line, to continuously dampproof below grade rooms or other internal spaces.

B. Dampproofing shall also be installed elsewhere, where noted on the Contract Drawings.

C. Protection board shall be applied at locations where foundation insulation is not otherwise provided in order to protect the dampproofing during backfill operations.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where dampproofing will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed dampproofing.

a. Surfaces to receive dampproofing shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the dampproofing materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the dampproofing Manufacturer.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Trowelable leveling and patching compounds shall be used per dampproofing Manufacturer's written instructions to fill cracks, holes, and depressions.

E. Immediately before application of dampproofing materials, scrape surfaces to be covered free from foreign materials and brush clean.

F. Substrate shall be swept to remove all loose materials prior to beginning dampproofing installation.

3.06 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

1. Do not begin dampproofing until penetrations have been installed so that dampproofing will not be penetrated or damaged by subsequent Work.

2. Do not begin dampproofing before plumbing, electrical, mechanical, and structural items under or passing through dampproofing have been secured in proper positions and appropriately sealed and protected.

3.07 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Particular care shall be given to the application of dampproofing at construction joints.

C. Primer, if recommended by the Manufacturer for the application, shall be applied per the Manufacturer's recommended procedures.

D. Surfaces to be dampproofed shall receive 2 heavy coats, the first coat being carefully applied so that "holidays" or untreated air-bubble depressions in the surface shall be completely filled and the second coat shall provide a 100 percent coating of the surface.

E. Install foundation insulation in Section 07 21 13 – Board Insulation, against dampproofing.

F. Dampproofing shall be cured prior to backfilling.

G. Install protection board against dampproofing as recommended in writing by the dampproofing manufacturer.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Dampproofing shall be protected from damage from subsequent construction operations.

B. The Contractor shall make adjustments required until accepted.

C. Damaged or defective items shall be removed and replaced as determined by the Engineer.

D. When dampproofing Work is completed, remove unused materials, containers, and equipment, and clean the Site of dampproofing debris.

END OF SECTION

SECTION 07 19 00 – WATER REPELLENTS

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide Surface Applied Water Repellants and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

American Society of Testing and Materials (ASTM)	
ASTM C 140	Water Repellency in Water Absorption
ASTM D 3278	Standard Test Method for Flashpoint of Liquids by Small Sealed Closed-End Apparatus
ASTM E 514	Standard Test Method for Water Penetration and Leakage through Masonry
Environmental Protection Agency (EPA)	
Method 24	Surface Coatings

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

C. Warranty: Submit a copy of the warranty.

D. Certifications:

1. Certification by the Surface Applied Water Repellant Manufacturer that the water repellant provided is suitable for, and compatible with, the required installation.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and Owner.

3. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and Owner.

4. Certification by the Manufacturer's field representative that surfaces have been prepared and the products have been applied in accordance with the Manufacturer's recommendations.

5. Certification by the Manufacturer that the products provided achieves a Class E rating, when tested in accordance with ASTM E 514.

6. Certification by the Manufacturer that the products supplied complies with local regulations controlling the use of volatile organic compounds (VOCs).

7. Certification by the Manufacturer's field representative that the products provided achieves a passing result when tested in accordance with RILEM Test Method II.4.

8. When requested by the Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Application Schedule: Furnish a detailed and complete application schedule indicating location and detail of installation.

F. Samples: When requested by Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish and quality of each item. Approval of samples shall not relieve Contractor from compliance with the Contract Documents.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Surface Applied Water Repellants shall be provided by a single Manufacturer.

B. Manufacturer Qualifications:

1. Surface Applied Water Repellant Manufacturer shall have a minimum of 20 years of water repellant manufacturing experience.

2. Surface Applied Water Repellants Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

3. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications:

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installer shall be trained, certified, and authorized by the Manufacturer to install the Manufacturer's product, when applicable.

3. Installers without these qualifications will not be accepted.

D. Manufacturer's Technical Field Representative: The Contractor shall arrange for a Manufacturer's technical field representative to be on Site, at the beginning of water repellent application (and periodically throughout), to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

E. Field Sample:

1. Coordinate field sample with other field samples required in other Sections.

2. Prior to installation, erect sample wall panel mock-up on Site using materials and joint details required for final Work. Provide special features as directed.

3. The field sample shall not exhibit any deterioration of color or finish of the substrate, including but not limited to discoloration, staining, streaking, and fading.

4. Apply material in accordance with the requirements in Part 3 – Execution, below.

5. Manufacturer's technical field representative shall be present to review technical aspects and conduct the field sample installation.

   a. Apply Surface Applied Water Repellant to 2 ft by 2 ft test panel area, in accordance with Manufacturer's written instructions, to determine coverage rates, effectiveness, aesthetics, and desired results.

   b. Allow 10 days or until test panels are thoroughly cured before evaluating final appearance and results.

   c. Conduct RILEM test method II.4 to evaluate water repellent performance.

   d. Do not begin full-scale application until test panels are inspected and approved by the Engineer.

   e. Do not begin full-scale application until test panels are inspected and approved.

6. Obtain the Engineer's acceptance of qualities of field sample before installation. Modify and/or reconstruct field sample at the direction of Engineer until acceptance. Retain field sample during construction as a standard for judging completed Work. Do not alter, move, or destroy field sample until directed by the Engineer.

7. Acceptance of field sample shall not relieve the Contractor from compliance with the Contract Documents.

1.05 SPECIAL WARRANTY PROVISIONS

A. The Contractor shall furnish Manufacturer’s extended 10-year warranty to cover defects in materials, products, and manufacturing workmanship.

B. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover defects in installation and associated later.

C. All warranty items shall be non-prorated for the entire warranty period.

D. The term of the warranty shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Surface Applied Water Repellant shall be a water-based, clear silane/siloxane sealer designed to provide protection for split-faced, lightweight and standard concrete masonry units.

2.02 SURFACE APPLIED WATER REPELLANT

A. Manufacturer and Product, or Equal:

1. Subject to the requirements herein, provide Manufacturer and product listed below, or equal.

a. Sika USA, Sikagard H 107.

2. Description:

a. Surface Applied Water Repellant shall comply with standard specification, ASTM D 3278 (>212 deg F [> 100 deg C]), ASTM C 140 (45 percent reduction in weight gain), ASTM E 514 (99 percent reduction in weight gain), and VOC content shall be less than 2.50 lb/gal (1.13 kg/liter) per EPA method 24.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Surface Applied Water Repellant shall be applied to above grade, exterior masonry veneer, exposed concrete masonry blocks, and all precast sills and caps.

B. Surface Applied Water Repellant shall also be applied elsewhere, where indicated on the Contract Drawings.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

C. Protect against uneven and excessive evaporation and from strong flows of dry air, both natural and artificial.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify coordination with adjacent Work.

1. Examine substrates, areas, and conditions where the product will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed the product.

    a. Surfaces to receive the product shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the Surface Applied Water Repellants materials.

    b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the Surface Applied Water Repellant Manufacturer.

C. Substrate shall be swept to remove all loose materials prior to beginning application.

3.06 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.07 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Surfaces shall receive complete coats and coverage rates as recommended in writing by the Manufacturer.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

3. The surfaces of materials adjoining the product shall be cleaned free of overspray and smears of the product or other soiling due to the installation of the product.

B. Upon completion of the application, the product and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, as determined by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. The Contractor shall make adjustments required and retest until accepted.

D. The product shall be protected from damage from subsequent construction operations.

E. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

F. When the product Work is completed, remove unused materials, containers, and equipment, and clean the Site of Surface Applied Water Repellant debris.

END OF SECTION

SECTION 07 21 13 – BOARD INSULATION

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes

1. Foundation insulation

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures
07 11 00	Dampproofing

D. Reference Standards

American Society for Testing and Materials (ASTM)3zx	
ASTM C 272	Standard Test Method for Water Absorption of Core Materials for Structural Sandwich Constructions
ASTM C 518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 578	Rigid, Cellular Polystyrene Thermal Insulation
ASTM D 1621	Standard Test Methods for Compressive Properties of Rigid Cellular Plastics
ASTM D 4716	Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certifications:

1. Certification by the Manufacturer that the foundation insulation is suitable for, and compatible with, the dampproofing provided under Section 07 11 00 – Dampproofing.

C. Application Schedule

1. Furnish a detailed and complete application schedule indicating location and detail of installation.

D. Samples

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish, and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility

1. Foundation insulation shall be provided by a single Manufacturer.

B. Qualifications

1. Manufacturer

a. Minimum of 10 years of foundation insulation manufacturing experience.

b. Minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

1.06 WARRANTY

A. Manufacturer Warranty

1. Furnish the Manufacturer's 15-year written thermal warranty.

2. Warranties shall be non-prorated for the entire warranty period.

PART 2 -- PRODUCTS

2.01 FOUNDATION INSULATION

A. Foundation insulation shall be suitable for, and compatible with, the dampproofing provided under 07 11 00 – Dampproofing.

2.02 MANUFACTURER

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. DuPont Styrofoam Perimate XPS Foam Insulation.

B. Description

1. Foundation insulation shall be a 2 1/8-in extruded closed cell polystyrene foam board with drainage grooves and with integral high-density skins of same material.

2. Foundation insulation shall comply with ASTM C 578 Type IV, and shall have a minimum R-value of 10.0 (5 per inch) at 75 deg F (23.9 deg C), sq ft × h × degrees F/Btu, in accordance with ASTM C 518. Foundation insulation shall have a minimum compressive strength of 30 psi in accordance with ASTM D 1621, maximum water absorption of 0.1 percent by volume, in accordance with ASTM C 272, and drainage capacity at 1200 psf, gradient 0.19 of 3 gal/min/ft in accordance with ASTM D 4716.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Install foundation insulation vertically to reach a depth of 3 ft 0-in below grade, or to depth shown on the Drawings (whichever is greater) to continuously insulate the exterior face of exterior foundation walls, and other surfaces and substrates where indicated, in strict accordance with Manufacturer's written instructions.

B. Foundation insulation shall also be installed elsewhere, where noted on the Drawings.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where foundation insulation will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed foundation insulation.

a. Surfaces to receive foundation insulation shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the foundation insulation materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor’s acceptance of the substrate, areas, and conditions.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer’s written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Foundation insulation shall be set with top 2-in below finish grade and held firmly in place in the freshly dampproofed concrete with additional daubs of dampproofing mastic in strict accordance with the Manufacturer's instructions. Refer to Section 07 11 00 – Dampproofing.

3.07 CLEANING, FINISHING, AND PROTECTION

A. Foundation insulation shall be protected from damage from subsequent construction operations.

B. The Contractor shall make adjustments required until accepted.

C. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

D. When foundation insulation Work is completed, remove unused materials, containers, and equipment, and clean the Site of foundation insulation debris.

END OF SECTION

SECTION 07 26 10 – UNDER SLAB VAPOR RETARDER

PART 1 - GENERAL

1.1 SCOPE

A. Provide and install under slab vapor barrier in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Use this Section with the Contract Documents and following other Sections to establish the total requirements

01 33 00	Submittal Procedures
03 30 50	Cast-in-Place Concrete
31 30 00	Earthwork Methods

1.3 APPLICABLE CODES AND STANDARDS

A. Where reference is made to any of the below, the revision in effect at the time of bid opening applies.

American Society of Testing and Materials (ASTM)	
ASTM E96	Standard Test Methods for Water Transmission of Materials
ASTM E154	Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
ASTM E1745	Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs
ASTM E1643	Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs

1.4 SUPPLIER SUBMITTALS

A. See Section 01 33 00 – Submittals

B. Product Data

a. Manufacturer’s samples and data sheets

b. Preparations instructions and recommendations

c. Storage and handling requirements and recommendations

d. Manufacturer’s installation instructions for placement, seaming, penetration prevention and repair, and perimeter seal per ASTM E1643

1.5 SHOP TESTING

A. Independent laboratory test results showing compliance with ASTM and ACI Standards

1.6 QUALITY ASSURANCE

A. Follow approved Quality Assurance/Quality Control Program

B. Designate a project manager for the duration of the project.

C. Membrane and accessories shall be from the same manufacturer.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.

B. Storage

a. Store products in manufacturer’s unopened packaging until ready for installation.

b. Store materials in a clean, dry area in accordance with manufacturer’s instructions.

C. Handling: Protect materials during handling and installation to prevent damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Vapor Retarder shall have all of the following qualities:

a. Maintain permeance of less than 0.01 Perms [grains/(ft^2·hr·inHg)] as tested in accordance with mandatory conditioning tests per ASTM E1745.

B. Other performance criteria

a. Strength: ASTM E1745 Class A

b. Thickness: 15 mils minimum

C. Provide third party documentation that all testing was performed on a single production roll per ASTM E1745

2.2 MANUFACTURERS

A. Subject to compliance with the requirements, for use between stable substrates and concrete slab, provide one of the following products or an equivalent product with written approval.

a. Stego Wrap 15 mil Vapor Barrier; Stego Industries LLC

b. VaporBlock 15 Underslab Vapor Retarder; Raven Industries

c. Moistop Ultra “A” 15 mil; Fortifiber Building Products Systems

2.3 ACCESSORIES

A. General: Ensure accessories are from the same manufacturer as the vapor retarder.

B. Seam Tape: High density polyethylene tape with pressure sensitive adhesive with a minimum width of four inches.

C. Pipe Boots: Construct pipe boots per the vapor retarder manufacturer’s published instructions.

D. Mastic: Vapor retarder manufacturer’s mastic specifically formulated to be compatible with vapor retarder and to fill voids around irregular penetrations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine surfaces and areas to receive reinforced vapor retarders.

a. Subgrade shall be approved by the Geotechnical Engineer

b. Subgrade shall be compacted and level

c. Exposed subgrade shall be moistened just prior to placement of the vapor retarder.

3.2 INSTALLATION

A. Locate vapor retarder membrane system directly beneath concrete slab.

B. Install vapor retarder in accordance with manufacturer’s published instructions and ASTM E1643.

C. Install vapor retarders in largest practical widths.

D. Overlap seams by six inches and seal with manufacturer’s seam tape.

E. Ensure surface beneath vapor retarder is smooth with no sharp projections.

F. Immediately repair holes in vapor retarder per manufacturer instructions.

G. Seal around pipes and other penetrations in vapor retarder with pipe boots in accordance with manufacturer instructions.

H. Ensure vapor retarder surfaces to receive tape are clean and dry.

3.3 PROTECTION

A. Protect vapor retarders from damage during installation of reinforced steel and utilities and during placement of concrete slab.

B. Immediately repair damaged vapor retarder in accordance with manufacturer's instructions.

END OF SECTION

SECTION 07 92 13 – ELASTOMERIC JOINT SEALANTS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Sealants and caulking.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Codes

01 33 00	Submittal Procedures
03 15 00	Concrete Accessories

D. Reference Standards

American Society for Testing and Materials (ASTM)	
ASTM C 920	Elastomeric Joint Sealants
ASTM D 1752	Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
Sealant, Waterproofing, and Restoration Institute (SWRI)	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. The Contractor shall coordinate color samples with other Sections through the submittal process, as required by the Engineer.

1.04 ACTION SUBMITTALS

A. Product Data

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

2. Joint width and depth tables.

3. Manufacturer's full range color charts, indicating custom color availability, for color selection by Owner.

B. Certifications:

1. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

2. Certification by the Manufacturer's technical field representative that surfaces have been prepared and the products have been applied in accordance with the Manufacturer's recommendations.

3. Certification from an independent testing laboratory that the submitted materials meet the requirements of the references indicated.

C. Application Schedule

1. Furnish a detailed and complete application schedule indicating location and detail of installation.

D. Samples

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility

1. Sealants and Caulking shall be provided by a single Manufacturer, each.

B. Qualifications

1. Manufacturer

a. Sealants and caulking Manufacturer shall have a minimum of 20 years of sealants and caulking manufacturing experience.

2. Installer

a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

C. Manufacturer's Technical Field Representative

1. The Contractor shall arrange for a Manufacturer's technical field representative to be on Site for at least 1 day, beginning at the start of surface preparation and continuing through application, to train the installers and to supervise the Work. The Manufacturer's technical field representative shall observe as necessary to certify in writing that the completed Work has been performed according to the Manufacturer's instructions.

D. Sealant and caulking Work shall comply with the following references:

1. SWRI.

2. ASTM C 920.

1.06 WARRANTY

A. Manufacturer

1. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Special Warranty

1. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

C. Warranties shall be non-prorated for the entire warranty period.

D. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Sealant and caulking, including compressible filler and joint backing, shall be recommended by the Manufacturer for the installation indicated.

B. Sealant and caulking, including compressible filler and joint backing, shall be suitable for, and compatible with, the required installation.

C. Sealant and caulking, including compressible filler and joint backing, shall be suitable for, and compatible with, the substrates and surfaces indicated.

D. Refer to Section 03 15 00 – Concrete Accessories for joint treatment in concrete hydraulic structures.

E. Colors for sealants and caulking above grade and exposed to view shall be selected by the Owner from Manufacturer's full color range, including custom colors.

2.02 INTERIOR AND EXTERIOR SEALANTS (HORIZONTAL OR SLOPED PLANES)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sikaflex SL2 by Sika Corporation, including primer as recommended by Manufacturer.

B. Description: Two part, pour grade polyurethane base, ASTM C 920, Type M, Grade P, Class 25, Use T, NT, M, A, and I.

2.03 INTERIOR AND EXTERIOR SEALANTS (VERTICAL PLANE)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sikaflex NP2 by Sika Corporation, including primer as recommended by Manufacturer.

B. Description: Multi-component, gun grade, polyurethane ASTM C 920, Type M, Grade NS Class 25, Use NT, T, M, A, G, and O.

2.04 COMPRESSIBLE FILLER

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer listed below, or equal:

a. WR Meadows, Inc.

B. Description:

1. Compressible filler shall be an impregnated preformed compressible sealant, produced by combining permanently elastic, high density open cell, polyurethane foam with stabilizing acrylics. Compressible filler shall be supplied pre-compressed in a tape form with a PSA on one side.

2. Compressible filler shall be compatible with sealant Manufacturer’s product and shall not stain the sealant nor the materials to which applied. Compressible filler shall comply with ASTM D 1752, Type II or III.

2.05 JOINT BACKING (BACKER ROD)

A. Description:

1. Joint backing for joints in superstructure shall be approved, resilient, closed cell polyethylene rods of diameters to suit joint conditions. Joint backing shall comply with ASTM C 1330 and ASTM D 5249.

2. Where joint depth will not allow for a rod and still provide 3/8-in minimum depth of sealant, provide approved bond breaker tape at the bottom of the joint.

3. Joint backing shall be compatible with sealant Manufacturer's product and shall not stain the sealant nor the materials to which applied.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Joints noted as "caulk," "caulking," or "sealant" shall be caulked as specified herein.

B. Joints to be caulked or sealed include through-bolt holes, door frames, louver and ventilator frames, joints between openings where items pass through exterior walls, concrete masonry, or combination of these surfaces, and as otherwise indicated or required for watertightness, weatherproofing, or airtightness.

1. Sealants and caulking shall be provided at both exterior and interior surfaces of exterior wall penetrations.

C. Sealants and caulking shall be provided at exterior wall joints, between adjacent materials, joints between frames or louvers and adjacent materials, copings, caps, sills, masonry control joints, and other joints and penetrations indicated or required for the completion of the Work.

D. Sealants and caulking shall be provided at interior joints between frames and masonry, at tops of masonry walls, between masonry and structural concrete, floor joints in tile, joints in rooms to be airtight, and other joints and penetrations on the Contract Drawings or as required for the completion of the Work.

E. Sealants and caulking shall also be installed elsewhere, where indicated on the Contract Drawings.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions, and referenced standards, for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where sealants and caulking will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed sealants and caulking.

a. Surfaces to receive sealants and caulking, including compressible filler and joint backing, shall be dry, free of oil, dirt, dust and other contaminants and loose materials, and shall be in the proper condition as indicated by the Manufacturer prior to the application of the sealant and caulking materials.

b. Masonry, concrete, and cementitious products shall have been completely cured and the surface shall be dry and free from frost at the time of application.

c. Joint shapes and sizes shall be as indicated. Where not indicated, joint shapes and sizes shall be as necessary for job conditions, as directed by the Engineer.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor’s acceptance of the substrate, areas, and conditions.

3.05 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the applicable references and with the Manufacturer’s written instructions.

B. Coatings, including curing compounds, form release agents, and other substances shall be removed as recommended by the sealant and caulking Manufacturer.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Laitance, efflorescence, and loose mortar shall be removed from the joint cavity.

E. Ferrous metal surfaces shall be cleaned of rust, mill scale, and other coatings by wire brush, grinding, or sandblasting.

F. Protective coatings shall be removed from surfaces to receive sealants and caulking.

1. Solvents used to remove protective coating shall be as recommended by the sealant and caulking Manufacturer, shall be compatible with the adjacent materials and surfaces, shall not damage adjacent finishes, and shall be non-staining.

G. Bituminous or resinous materials shall be removed from surfaces to receive sealants and caulking.

H. Immediately before application of sealant and caulking materials, scrape surfaces to be covered free from foreign materials and brush clean.

I. Substrate shall be swept to remove all loose materials prior to beginning sealant and caulking installation.

3.06 PREPARATION

A. Sequence installation properly with the installation and protection of other WORK, so that neither will be damaged by the installation of the other.

3.07 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, and with Manufacturer’s written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Primer, if recommended by the Manufacturer for the application, shall be applied per the Manufacturer's recommended procedures.

1. Primer shall be used on concrete masonry units, wood, or other porous surfaces in accordance with instructions furnished with the sealant. Primer shall be applied to the joint surfaces to be sealed. Surfaces adjacent to joints shall not be primed.

C. Multi-component sealants shall be mixed according to Manufacturer’s printed instructions. Sealant in guns shall be applied with a nozzle of proper size to fit the width of joint. Sealant shall be installed to the required depth without displacing the backing. Unless otherwise indicated or recommended by the Manufacturer, the installed sealant shall be tooled so that the surface is uniformly smooth and free of wrinkles and to assure full adhesion to the sides of the joint. Sealants shall be installed free of air pockets, foreign embedded matter, ridges, and sags. Sealer shall be applied over the sealant if recommended by the sealant Manufacturer.

D. Sealant depth in joints shall be half of the width of joint, but not less than 1/8-in deep and ¼-in wide nor more than 1/2-in deep and 1-in. For joints greater than 1-in wide, provide sealant in a 2 to 1 width-to-depth ratio.

E. Joints shall have a rigid filler material installed to proper depth prior to application of sealant.

F. Masking film shall be placed on the finish surface on one or both sides of a joint cavity to protect adjacent finish surfaces from primer or sealant smears. Masking shall be removed as soon as possible after joint has been filled and tooled.

G. Backing shall be installed to provide the indicated sealant depth. The installation tool shall be shaped to avoid puncturing the backing.

H. Bond-breaker shall be applied to fully cover the bottom of the joint without contaminating the sides where sealant adhesion is required.

I. A full bead of sealant shall be applied into the joint under sufficient pressure, with the nozzle drawn across sealant, to completely fill the void space and to ensure complete wetting of contact area to obtain uniform adhesion. During application, the tip of the nozzle shall be kept at the bottom of the joint thereby forcing the sealant to fill from the bottom to the top. Sealants shall be tooled immediately after exposure with a caulking tool or soft bristled brush moistened with solvent. The finished sealant-filled joint shall be slightly concave unless otherwise indicated.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

3. The surfaces of materials adjoining caulked joints shall be cleaned free of smears of sealant or other soiling due to caulking operations.

B. Sealants and caulking shall be protected from damage from subsequent construction operations.

C. The Contractors shall make adjustments required until accepted.

D. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

E. When sealant and caulking Work is completed, remove unused materials, containers, and equipment, and clean the Site of sealant and caulking debris.

END OF SECTION

SECTION 08 11 13 – HOLLOW METAL DOORS AND FRAMES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Steel doors and frames.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
08 71 00	Door Hardware
09 96 00.10	High Performance Coatings

C. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

D. Reference Standards

American National Standards Institute (ANSI) / Steel Door Institute (SDI)	
ANSI A 115 -	Specification for Preparation of Steel Doors and Frames for Hardware
ANSI/SDI A 250.6 -	Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames
ANSI A 250.8/SDI 100-	Recommended Specifications for Standard Steel Doors and Frames
ASTM International (ASTM)	
ASTM A 153	Zinc Coating (Hot Dip) on Iron and Steel Hardware
ASTM A 653	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
Building Code	
Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code	
National Fire Protection Association (NFPA)	
NFPA 80	Fire Doors and Windows
NFPA 252	Standard Methods of Fire Tests of Door Assemblies
Steel Door Institute (SDI)	

Recommended Locations for Builders' Hardware for Standards Steel Doors and Frames	
Underwriters' Laboratories (UL)	
UL 10	Standard for Fire Test Door and Assemblies
UL 10C	Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS

A. Product Furnish submittals in accordance with Section 01 33 00 –Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions.

B. Certifications:

1. Certification of compliance with the requirements of paragraph 2.1.A.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

4. Submit certification from a recognized testing agency that fire doors have passed tests to meet fire ratings indicated.

5. Certification from the Manufacturer stating that galvanizing has been completed in accordance with these specifications.

6. Certification from the Manufacturer stating that the rust-inhibitive primer is compatible with painting systems in Section 09 96 00.10 – High Performance Coatings.

C. Shop Drawings: Complete Shop Drawings showing location and detail of installation.

1. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each door and frame type, schedule of doors and frames, frame elevations and details, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

2. Include details of core and edge construction, through-door louvers, vision panels, and trim for openings.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 6-in by 6-in frame corner construction, including galvanizing, welding, grinding, touch-up, and priming.

3. 6-in by 6-in door panel construction, including galvanizing, welding, grinding, touch-up, and priming.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Steel doors and frames shall be provided by a single Manufacturer.

B. Steel doors and frames shall conform to ANSI A 250.8/SDI 100, except where more stringent requirements are indicated herein.

C. Fire Rated Openings:

1. Steel doors and frames required to be fire-rated shall bear UL labels indicating the applicable fire ratings. Designs and construction of such products shall have specific UL approval according to current procedures for the fire rating. Assemblies shall be constructed to comply with NFPA 80, with the Code, and with other requirements indicated.

2. Steel doors and frame assemblies and components shall be compliant with positive pressure and S-label requirements. Steel doors and frames shall be coordinated with door hardware supplier to ensure that total opening installation is compatible with UL 10C and NFPA 252.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Steel doors and frames, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

    a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials if required to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Refer to Section 08 71 00 – Door Hardware, for door hardware to be provided for Steel Doors and Frames.

2.02 STEEL DOORS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below:

    a. Curries Co., (ASSA ABLOY Group); 777E Series modified by the Manufacturer with custom upgraded features as required to comply with the Specifications.

    b. Steelcraft

    c. Pioneer

    d. Ceco

B. Description:

1. Provide flush design steel doors, 1 ¾-in thick, seamless hollow construction, unless otherwise indicated.

2. Exterior Doors: 14-gauge galvanized sheet steel, SDI Level 4 Classification

3. Interior Doors: 16-gauge galvanized sheet steel, SDI Level 3-Model; 2 Classification

4. Galvanized steel sheets shall be zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 653, G90 zinc coating, mill phosphatized.

5. For single-acting swing doors, vertical edge at lock edge shall be beveled 1/8-in in 2-in.

6. Doors shall be fabricated of 2 outer, galvanized, stretcher-leveled steel sheets not less than 16-gauge. Doors shall be constructed with smooth, flush surfaces without visible joints or seams on exposed faces or stile edges. Weep hole openings shall be provided in the bottom of doors to permit escape of entrapped moisture.

7. Inside of doors shall be reinforced with vertical galvanized sheet steel Sections not less than 22-gauge. Vertical reinforcing shall be spaced 6-in on center and extend full door height. Spot-weld at not more than 5-in on center to both face sheets.

8. Insulate spaces between door ribs with one pound, nominal density fiberglass insulation. R-value of door shall be at least 2.78 hr/Btu/sq. ft./deg F.

9. Tops and bottoms of doors shall be reinforced with 16-gauge horizontal steel channels welded continuously to outer sheets. Top and bottom edges shall be closed to provide seal, as integral part of door construction while providing recesses for required hardware and appurtenances.

C. Door Hardware Reinforcement:

1. Components shall be reinforced for hardware installation in accordance with ANSI/SDI A 250.6.

a. Lock and closer reinforcements shall be “box” or “channel” type.

b. Punch single leaf frames to receive 3 silencers. Double leaf frames shall receive one silencer per leaf at head.

c. Factory prepared hardware locations shall be in accordance with “Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames,” as adopted by SDI.

d. Supply welded in mortar guards at hardware cutouts in frames built into masonry or grouted in full.

2.03 STEEL FRAMES

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Curries Co., (ASSA ABLOY Group); Masonry/Flush Frame M Type (Equal Rabbet).

B. Description:

1. Provide hollow metal frames for doors, windows, lites, cased openings, and for other openings where indicated. Frames shall be 14-gauge galvanized sheet steel, 5 ¾- in wide by 2-in deep, unless otherwise indicated.

a. Stops shall be formed integral with the frame unless otherwise indicated.

b. Provide removable stops where indicated or required on secured room side of opening, formed of not less than 18-gauge steel sheets. Secure with oval head machine screws spaced uniformly not more than 12-in on center. Form corners with butted hairline joints.

1) Coordinate width of rabbet between fixed and removable stops with type of glass, panel, and type of installation indicated.

c. Galvanized steel sheets shall be zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 653, G90 zinc coating, mill phosphatized.

2. Frames shall be fabricated of welded unit construction, with corners mitered, reinforced, and face welded. No field-spliced frames will be allowed.

3. Provide temporary shipping bars to help protect from damage during transit and handling.

4. Temporary shipping bars shall be removed before setting frames.

5. Welds on frames shall be flush with neatly mitered or butted material cuts.

6. Frames shall be pretreated prior to priming at factory by washing, phosphatizing and by chromic seal. Primer shall be baked on.

C. Jamb Anchors:

1. Provide UL approved fixed anchors at fire rated openings.

D. Floor Anchors: Angle clip type.

1. 16-gauge minimum.

2. 2 fasteners per jamb.

3. Welded to the bottom of each jamb.

E. Preparation for Hardware:

1. Reinforcement: Components shall be reinforced for hardware installation in accord with ANSI/SDI A250.6.

2. Lock and closer reinforcements shall be “box” or “channel” type.

3. Punch single leaf frames to receive 3 silencers. Double leaf frames shall receive one silencer per leaf at head.

4. Factory prepared hardware locations shall be in accordance with “Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames,” as adopted by the SDI.

5. Supply welded in mortar guards at hardware cutouts in frames built into masonry or grouted in full.

F. Head Reinforcing: For frames over 4-ft 0-in wide in masonry wall openings, provide continuous steel channel or angle stiffener, not less than 12-gauge for full width of opening, welded to back of frame at head.

G. Spreader Bars: Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions.

H. Plaster Guards: Provide 26-gauge galvanized steel plaster guards or dust cover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware installation.

2.04 FABRICATION

A. The Contractor shall field verify size, location, and placement of doors and frames, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

B. Doors and frames shall be fabricated to be rigid, neat in appearance, and free from defects, including warping, cupping, buckling, or other defects. Metal shall be accurately formed to required sizes and profiles.

C. Doors and frames shall be fit and assembled in the Manufacturer's plant. Weld exposed joints continuously; grind, dress, and make smooth, flush, and invisible. Metallic filler to conceal manufacturing defects is not acceptable.

D. Doors and frames shall be prepared to receive mortised and concealed door hardware, including cutouts, reinforcing, drilling, and tapping in accordance with final Door Hardware Schedule and templates provided by hardware supplier, and as indicated in the Contract Documents.

1. Comply with applicable requirements of ANSI A 115 for preparation for hardware on doors and frames.

2. Include thru-bolting holes as required per hardware template.

3. Do not include unnecessary cutouts in door faces not required by hardware template.

4. Doors and frames shall be reinforced to receive surface-applied hardware. Drilling and tapping for surface-applied door hardware may be done at Site.

E. Shop Surface Preparation and Priming:

1. Steel surfaces shall be cleaned of dust, dirt, mill scale, rust, oil, grease, and other foreign materials.

a. Zinc-rich primer shall be applied to damaged galvanized surfaces.

2. Pretreatment shall be applied to cleaned metal surfaces, using cold phosphate solution or hot phosphate solution.

3. One full shop coat of rust-inhibitive primer shall be applied within time limits recommended by pretreatment Manufacturer. A smooth coat of even consistency shall be applied to provide a uniform dry film thickness of not less than 2.0 mils.

F. Zinc-Rich Touch-up Primer: Use 95 percent metallic zinc dust primer in a vehicle compatible with the epoxy painting systems in Section 09 96 00.10 – High Performance Coatings.

G. Supports and Anchors: Fabricate of not less than 16-gauge sheet metal. Galvanize after fabrication units complying with ASTM A 153, Class B.

H. Inserts, Bolts, and Fasteners: Hot-dip galvanize, complying with ASTM A 153, Class C or D, as applicable.

I. Rust-Inhibitive Primer:

1. Air-drying or baking type compatible with epoxy finish paint in Section 09 96 00.10 – High Performance Coatings.

2. Provide non-standard primer if required to obtain compatibility.

J. Steel doors and frames shall be field painted per Section 09 96 00.10 – High Performance Coatings.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Steel doors and frames shall be shipped and stored with temporary stiffeners and spacers in place to prevent distortion.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where doors and frames will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed doors and frames.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of steel doors and frames. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the Steel Doors and Frames and appurtenances.

E. Placing Frames: Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.

F. Remove spreader bars only after frames or bucks have been properly set and secured.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

   1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

   2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, doors and frames and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

   1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

   2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the doors and frames.

   1. Doors and frames shall operate smoothly, quietly, and without squeaking and binding.

D. Immediately after installation, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.

E. Doors and frames shall be protected from damage from subsequent construction operations.

F. The Contractor shall make adjustments required and retest until accepted.

G. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

H. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

   1. Remove and replace defective Work, including doors or frames that are warped, bowed, or otherwise unacceptable.

I. When door and frame Work is completed, remove unused materials, containers, and equipment, and clean the Site of door and frame debris.

END OF SECTION

SECTION 08 23 00 – OVERHEAD COILING DOORS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Overhead coiling doors with operating assemblies, curtains, guides, hardware, and accessories as required for complete, operational installation.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

C. Reference Standards

ASTM International (ASTM)	
ASTM A123	Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
ASTM A153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A653.	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM D3363	Standard Test Method for Film Hardness by Pencil Test.
National Electrical Manufacturers Association (NEMA)	
NEMA Standard KS 1	Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

1. Building Code: Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the CODE”.

2. NEMA 4X – Enclosures intended for indoor or outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water.

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

    a. Complete operation instructions.

    b. Manufacturer's full-range color charts, indicating custom color availability for color selection by the Owner.

2. Certificates:

    a. Certification by the overhead coiling door Manufacturer that the overhead coiling doors provided are suitable for, and compatible with, the required installation.

    b. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

B. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional structural engineer licensed per local engineering laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each overhead coiling door type, schedule of overhead coiling doors, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

    a. Shop Drawings shall include material descriptions, door guides, finish, color, details of construction, installation, accessories, and operation of each overhead coiling door type.

C. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 3-in by 4-in color samples showing substrate, finish, and color.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Overhead coiling doors shall be provided by a single Manufacturer.

B. Qualifications:

1. Manufacturers:

a. Overhead coiling doors Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

a. Installer shall be trained, certified, and authorized by the Manufacturer to install the Manufacturer's product.

1.07 WARRANTY

A. Manufacturer Warranty:

1. For overhead coiling door and appurtenances furnish Manufacturer's 2-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. The Contractor shall furnish separate, but concurrently running, 2-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Overhead coiling doors, including related assemblies, components, and attachment details shall comply with the CODE and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the CODE. Where a conflict occurs between the requirements of this Section and the CODE, the more stringent shall apply.

a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Design Requirements:

1. The Contractor shall furnish professional design and engineering services as required for overhead coiling doors.

a. Professional design and engineering services may be provided by the Manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

2. The Contractor shall coordinate color samples with other Sections through the submittal process.

2.02 OVERHEAD COILING DOORS

A. Manufacturers and Products:

1. Subject to the requirements indicated, provide Manufacturer and product listed below.

a. Cornell Iron Works, Inc.; Thermiser ESD20 & ESD20W – With Additional Options and Custom Features as specified herein.

b. The Cookson Company; Temp-Pro Rolling Service Door.

c. Wayne Dalton; Thermotite Model 800C

B. Description:

1. Overhead coiling doors shall be insulated slat, interior mounted, motor operated with chain-hoist override, with factory applied finish and color as indicated.

a. Steel Doors: Interlocking slats of galvanized steel skins conforming to Grade 40 galvanized steel zinc coating, in accordance with ASTM A653. Each slat shall be formed of exterior 20-gauge, interior 24-gauge, galvanized steel sheets.

2. Fabricate interlocking sections with end-locks on slats to maintain slat alignment, prevent wear, and to comply with requirements.

C. Insulation:

1. 7/8-in foamed in placed, closed cell polyurethane insulation enclosed in each slat.

2. Total slat R-value: 8.0 hr/Btu/sq ft/deg F minimum.

D. Bottom Bar:

1. Reinforced extruded aluminum interior face with full depth insulation and exterior skin slat to match curtain material and gauge.

2. Finish and color of interior and exterior surfaces shall match slats.

3. Provide with Manufacturer’s standard cylinder lock option.

E. Guides:

1. Minimum of 3/16-in galvanized structural steel and with sufficient depth to retain the curtains in the guides against the design loads. Provide aluminum guides for aluminum doors.

2. When wind-locks are necessary in order to comply with the requirements, provide wind-lock bars of same material as the guides.

3. Provide removable guide stoppers to prevent over-travel of curtain and bottom bar.

4. For steel door guides only – Top 16 ½-in of coil side guide angles shall be removable for ease of door installation and as needed for future door service.

5. Provide wind-locks of same material to comply with requirements.

6. Provide a padlockable chain keeper on guide.

F. Counterbalance, Brackets, and Hood:

1. Fabricated in accordance with the Manufacturer's standard practice.

2. The coil shall be housed in a 24-gauge galvanized steel sheet metal hood with reinforced top and bottom edges.

3. Provide minimum ¼-in steel intermediate-support brackets as required to prevent excessive sag.

4. Finish shall match the slats.

G. Weatherstripping:

1. Bottom bar: At motor operated doors, provide weatherseal with sensing feature, neoprene extending full width of door.

2. Guides: Provide replaceable vinyl strip sealing against fascia side of door.

3. Lintel: provide nylon brush seal fitted at door header to impede airflow.

4. Hood: provide neoprene / rayon baffle to impede airflow above coil.

H. Locking: Pad-lockable slide bolt on fascia side of bottom bar at each jamb extending into slots in guides.

2.03 FINISH AND COLOR

A. Steel Components:

1. Galvanizing:

a. Sheet steel shall be provided with a zinc coating at not less than 0.90-oz/sq-ft of steel and in a manner as to provide a ductile coating, tightly adhered to base metal and conforming to bond tests converted in accordance with ASTM A 653.

b. Structural shapes and similar heavy steel shall be hot-dipped galvanized per ASTM A123 and ASTM A153, as applicable. Provide phosphate coating for paint adhesion at the factory.

B. Steel Door Finish:

1. Provide Manufacturer's fusion bonded thermosetting powder cost finish applied to a minimum 2.5 mils cured film thickness.

2. Pencil hardness to be rated H or better per ASTM D3363.

C. Color:

1. Color shall be selected and approved by the Owner from Manufacturer's full color range including custom colors and may be required to exactly match other building components, as determined by the Owner.

a. Tentative color selection: To be Selected.

1) The Owner reserves the option of changing this tentative color selection during the submittal process.

2.04 OPERATION

A. General:

1. Provide UL listed electric door operator assembly of the size and capacity recommended in writing by the door Manufacturer; complete with electric motor and factory-prewired motor controls, worm-gear reduction unit, solenoid operated brake, clutch, and control station.

2. Provide auxiliary reduced drive chain hoist with electrically interlocked floor level disconnect for manual operation. Hoist wheel shall be easily moveable to right or left hand side of the unit.

B. Electric Door Operators (Basis of Design: Chamberlain Liftmaster, Model GH with options and custom features as specified herein.)

1. Provide 460-volt, 3-phase motors NEMA 4X rated. Motors shall be high starting torque, continuous duty, industrial type, protected against overload by a current sensing or thermal overload device. Speed reduction shall be worm-gear-in-oil-bath gear reducer with synthetic “All Climate” oil. Door drive shall utilize minimum #50 roller chain and sprockets.

2. Operator shall be equipped with an electrically interlocked floor level disconnect and chain hoist for manual operation and an electric solenoid-actuated brake to stop the motor and hold the door in position.

3. Operator shall be capable of driving the door at a speed of 8 to 9-in per second. Fully adjustable, driven linear type limit switch mechanism shall synchronize the operator with the door. Low friction nylon limit nuts fitted on threaded steel shaft, rotating on iolite self-lubricating bronze bushings.

4. The motor shall be removable without affecting the limit switch settings.

5. Coordinate wiring requirements and current characteristics of motors with the building electrical system; see Division 16 Sections of these specifications.

C. Remote Control Station:

1. Provide momentary-contact, 3-button control stations with push button controls labeled “open,” “close,” and “stop.” Install at location as shown, scheduled, or as directed by the Engineer.

2. Provide interior units full-guarded type, surface-mounted, heavy-duty, weatherproof, NEMA 4X enclosures.

D. Weather/Sensing Edge:

1. Provide automatic reversing control by an automatic sensing switch within neoprene or rubber astragal extending full width of door bottom bar. Contact before door fully closes shall cause door to immediately stop downward travel and reverse direction to the fully opened position. Provide retracting safety cord and reel connection to control circuit.

2.05 FABRICATION

A. The Contractor shall field verify size, location, and placement of overhead coiling doors, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Overhead coiling doors shall be assembled before shipment to the Site.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where doors and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed doors and appurtenances.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of overhead coiling doors. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the CODE, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the overhead coiling doors and appurtenances.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Anchors for guides, brackets, and other fasteners shall be provided as required.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, overhead coiling doors and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the overhead coiling doors and appurtenances.

1. Overhead coiling doors shall operate smoothly, quietly, and without squeaking and binding.

D. Overhead coiling doors shall be protected from damage from subsequent construction operations.

E. The Contractor shall make adjustments required and retest until accepted.

F. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

G. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

H. When overhead coiling doors Work is completed, remove unused materials, containers, and equipment, and clean the Site of overhead coiling doors debris.

END OF SECTION

SECTION 08 51 13 – ALUMINUM WINDOWS

PART 1 -- GENERAL

1.01 SUMMARY

A. Aluminum windows and window accessories.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
07 92 13	Elastomeric Joint Sealants
08 81 00	Glass Glazing

D. Reference Standards

American Architectural Manufacturer's Association (AAMA)	
AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
AAMA 1503	Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections
American National Standards Institute (ANSI)	
ANSI A 117.1	Accessible and Useable Buildings and Facilities
ASTM International (ASTM)	
ASTM A 36	Structural Steel
ASTM B 209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM B 221	Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes
ASTM B 308	Aluminum-Alloy 6061-T6 Standard Structural Shapes, Rolled or Extruded
ASTM C 509	Cellular Elastomeric Pre-formed Gasket and Sealing Material
ASTM C 864	Dense Elastomeric Compression Seal Gaskets, Setting Blocks and Spacers

ASTM E 283	Standard Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen
ASTM E 330	Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
ASTM E 331	Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference
American Welding Society (AWS)	
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as the Code.
Federal Specification (FS)	
FS TT-P-645	Primer, Paint, Zinc Chromate, Alkyd Type
Society for Protective Coatings (SSPC)	
SSPC Paint 12	Cold-Applied Asphalt Mastic (Extra Thick Film)
Flat Glass Marketing Association (FGMA) Glazing Manual	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

a. Manufacturer's full-range color charts, indicating custom color availability for color selection by the Owner.

2. Certificates:

a. Certification of compliance with the requirements of paragraph 2.1.A.

b. Certified copies of recent test reports of systems similar to the design for this project substantiating performance of system in lieu of re-testing. Other supportive data shall be included as necessary.

c. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of five (5) similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general Contractor, and owner.

B. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional civil engineer licensed per local engineering licensing laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each window frame type, schedule of window frames, frame elevations and details, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

    a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each aluminum window type.

    b. Shop Drawings shall include thermal breaks, details of special shapes, location and types of exposed fasteners and joints, and joint sealant.

    c. Shop Drawings shall indicate typical glazing details, locations of various types and thickness of glazing, and internal sealant requirements and details as recommended by the glazing sealant manufacturer.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Aluminum windows shall be provided by a single manufacturer.

B. Qualifications:

1. Manufacturers:

    a. Aluminum window manufacturer shall have a minimum of five (5) similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

    a. Installer shall have a minimum of five (5) years' experience in the successful completion of at least five (5) projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

3. Licensed Professionals:

    a. A professional civil engineer licensed per local engineering licensing laws shall design the aluminum windows and connections to the structure.

C. Installation shall be in accordance with the AAMA “Metal Curtain Wall, Window, Storefront and Entrance Guide Specification Manual,” the SFM-1 “Aluminum Storefront and Entrance Manual,” and other applicable references and with manufacturer's written instructions.

D. Testing Requirements: Components shall be provided that have been previously tested by an independent testing laboratory.

E. Welding shall be performed by AWS qualified welders.

F. In addition to requirements indicated, Contractor shall comply with applicable provisions of the Aluminum Curtain Wall Design Guide Manual for design, materials, fabrication, and installation of component parts.

1.07 WARRANTY

A. Manufacturer Warranty

1. Furnish manufacturer’s 2-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. Furnish manufacturer’s extended 20-year warranty to cover the finish.

a. Warranty shall include provisions for failures of the finish including, but not limited to, chalking, crazing, peeling, and fading.

3. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

4. Warranties shall be non-prorated for the entire warranty period.

5. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Structural Requirements:

1. Aluminum windows, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Aluminum windows shall be recommended by the manufacturer for the installation indicated.

C. Aluminum windows shall be suitable for, and compatible with, the required installation.

D. Design Requirements:

1. The Contractor shall furnish professional design and engineering services as required for aluminum windows.

    a. Professional design and engineering services may be provided by the manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

2. Contractor shall coordinate color samples with other Sections through the submittal process.

3. Supports, anchorage, and accessories shall be provided as required for complete assembly.

4. Aluminum window system manufacturer shall furnish the systems herein, including necessary modifications to meet the indicated requirements and to maintain visual design concepts as approved by the Engineer.

5. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant manufacturer's recommended joint design.

6. Contractor shall not assume glazing, sealant and interior finishes contribute to framing member strength, stiffness, or lateral stability.

7. Assemblies shall be free from vibration harmonics, rattles, wind whistles, and noise due to thermal movement, thermal movement transmitted to other building elements, and wind pressure. Assemblies shall be free from loosening, weakening, or fracturing of attachments by components.

8. Attachment considerations are to take into account Site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening, or fracturing connection between units and building structure or between units themselves.

9. System shall drain any water entering system to the exterior of system.

10. Concealed fastening shall be provided.

11. Uniform color and profile appearance shall be provided at components exposed to view.

E. Performance Requirements:

1. Fixed Windows:

Air Infiltration (ASTM E 283)	Maximum 0.06 cfm/sq ft surface area, at differential static pressure of 6.24 psf
Water Infiltration (ASTM E 331)	No water penetration at test pressure of 8 psf
Maximum Deflection (ASTM E 330)	L/175 of span at structural design criteria indicated, allowable stress with a safety factor of 1.65

2. Operable Windows:

Air Infiltration (ASTM E 283)	Maximum 0.030 cfm/sq ft surface area, at differential static pressure of 1.57 psf
Water Infiltration (ASTM E 331)	No water penetration at test pressure of 10.0 psf
Maximum Deflection (ASTM E 330)	When closed and locked, maximum deflection of L/175 at pressure difference of 65 psf

F. Thermal Requirements:

1. Fixed Windows:

a. Thermal Transmittance Performance (AAMA 1503): U-Value 0.63.

b. Condensation Resistance Factor (CRF) 63.

2. Operable Windows:

a. Thermal transmittance performance (AAMA 503.1): U-Value 0.70.

b. Condensation resistance factor (CRF): 49.

G. Aluminum window systems shall accommodate expansion and contraction movement due to surface temperature differentials without causing buckling, stresses on adjacent work, undue stress on structural elements, damaging loads on fasteners, reduction of performance, stress on glazing, failure of joint seals, or other visual or technical detrimental effects.

2.02 ACCEPTABLE MANUFACTUERS

A. Manufacturer and Product:

1. Subject to the requirements indicated, provide manufacturer and product listed below or equal.

a. Fixed Windows – Kawneer Co. Inc.; Trifab Versaglaze 451T Center Glazed Storefront System (with Thermal Break).

b. Operable Windows (Project-out Windows) – Kawneer Co. Inc.; 8225 TL Series Project-out Windows.

c. Equal products by Wausau Window and Wall Systems, or Tubelite Inc.

2.03 ALUMINUM WINDOWS

A. ASTM B 221, alloy 6063-T5 for extrusions; ASTM B 209, alloy 5005-H34 for sheets; or other alloys and temper recommended by manufacturer appropriate for the finish.

B. Internal reinforcing shall be ASTM A 36 for carbon steel; or ASTM B 308 for structural aluminum.

1. Shapes and sizes to suit installation.

2. Steel shall be galvanized and apply shop-coat steel components after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.

C. Inserts and anchoring devices shall be manufacturer's standard formed or fabricated assemblies, steel or aluminum, of shapes, plates, bars, or tubes.

1. Steel shall be galvanized and apply shop-coat steel components after fabrication with alkyd type zinc chromate primer complying with FS TT-P-645.

D. Fasteners shall be aluminum, non-magnetic stainless steel or other materials warranted by manufacturer to be non-corrosive and compatible with components being fastened.

1. Exposed fasteners shall not be used.

2. For concealed locations, manufacturer's standard fasteners shall be provided.

3. Provide nuts or washers of design having means to prevent disengagement; deforming of fastener threads is unacceptable.

E. Operable windows shall conform to the requirements of ANSI Standard A 117.1.

2.04 ACCESSORIES

A. Sill Extensions: Sill extensions shall be a one-piece extruded 0.060 aluminum.

B. Sill extension finish shall be the same as window, custom color to match adjacent exterior wall, as approved by Engineer.

C. Expansion anchor devices: Lead-shield or toothed-steel, drilled-in, expansion bolt anchors.

D. Shims: Non-staining, non-ferrous, type as recommended by system manufacturer.

E. Protective Coatings: To separate dissimilar materials, provide cold applied asphalt mastic complying with the SSPC Paint 12, compounded for 30-mil thickness for each coat; or alkyd type zinc chromate primer complying with FS TT-P-645.

1. Glazing Gaskets:

2. Compression type design, replaceable, molded or extruded neoprene, or ethylene propylene diene monomer (EPDM).

3. Glazing gasket shall comply with ASTM C 509 or ASTM C 864

4. Profile and hardness shall be as necessary to maintain uniform pressure for watertight seal.

5. Provide in manufacturer's standard black color.

6. Factory molded corners shall be required at exterior.

F. Internal Sealant: Types recommended by sealant manufacturer to remain permanently elastic, tacky, non-drying, non-migrating and weather tight.

G. “Anti-walk” Edge Blocking: “W” shaped EPDM blocks for use in keeping glazing material stationary under vibration or seismic loading. Edge blocking may be used for pressure plate systems.

H. Weatherstripping: Extruded EPDM elastomeric conforming to ASTM C 509 or C 864.

I. Baffles at Weepholes for Aluminum Framed Systems: Type as recommended by system manufacturer and shown in published installation instructions.

2.05 FINISH AND COLOR

A. Finish system shall be 2.0-mil, PVF2 Kynar 500, formulated by a licensed formulator to contain 70 percent PVF resin and applied by a licensed applicator.

1. Epoxy prime coat shall be applied to exposed sides to a dry film thickness of approximately 0.2-mil. One coat of PVF color coating shall be applied to exposed sides to provide a dry film thickness of not less than 0.8-mil, for a total of 1.0-mil total coating.

2. The surface condition of this finish coat shall be 100 percent free of holidays, drip marks, scratches, roll marks, or abrasions that are visible from a distance of 5 ft in good light when in installed position. Surfaces shall be free of checking, crazing, peeling, or loss of adhesion.

3. Finish shall meet or exceed AAMA 2605.

4. Color shall be selected and approved by the Owner from manufacturer’s full color range including custom colors, and may be required to exactly match other building components, as determined by the Owner.

a. Tentative color selection: Colors shall exactly match colors indicated below, as selected and approved by the Engineer.

1) PPG Industries, Inc., UC 101565 Duranar, Moosgrau as selected and approved by the Engineer.

b. Color shall be uniform with no variation in shade, and aluminum windows or accessories of different color batches will not be acceptable

c. The Owner reserves the option of changing this tentative color selection during the submittal process.

2.06 FABRICATION

A. The Contractor shall field verify size, location, and placement of aluminum windows, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

   1. Aluminum windows shall be assembled before shipment to the Site.

B. Accurate relation of planes and angles shall be maintained, with hairline fit of contacting members.

C. The Contractor shall make provisions in framing for minimum edge clearance, nominal edge cover, and nominal pocket width for thickness and type of glazing or infill used in accordance with recommendations of manufacturer and the Flat Glass Marketing Association (FGMA) Glazing Manual.

   1. Refer to Section 08 81 00 – Glass Glazing.

D. Welding shall comply with AWS recommendations.

   1. Recommended electrodes and methods shall be used to avoid distortion and discoloration.

   2. Grind exposed welds smooth and flush with adjacent surfaces; restore mechanical finish.

E. Holes or slots, deflector plates, water deflectors, and sealant shall be provided to accommodate internal weep and drainage to the exterior.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with manufacturer’s written instructions.

3.02 PROJECT CONDITIONS

A. Comply with manufacturer’s written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

1. Systems and components shall be inspected before installation.

2. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

3. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

B. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where aluminum windows and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed aluminum windows.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other work for the installation of aluminum windows. Coordinate delivery with other work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate the Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the aluminum windows and appurtenances.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Sill extensions shall be provided at exterior aluminum window installations.

G. Tolerances:

1. Limit variations from plumb and level:

a. ⅛-in in 20 ft vertically and horizontally.

b. ¼-in in 40 ft either direction.

2. Limit offsets in theoretical end-to-end and edge-to-edge alignment:

a. Allow 1/16-in where surfaces are flush or less than ½-in out of flush and separated by not more than 2 in.

b. 1/8-in for surfaces separated by more than 2-in.

3. Step in Face: 1/16-in maximum.

4. Jog in Alignment: 1/16-in maximum.

5. Location: ¼-in maximum deviation of any member at any location.

6. Tolerances are not accumulative.

H. Sealants:

1. Internal metal-to-metal joints shall be caulked, where required to provide the required performance as components are installed.

2. Perimeter members shall be sealed per manufacturer's installation instructions or as required for unique job conditions. Set other members with internal sealant and baffles as required by manufacturer's installation instructions. Use ultraviolet resistant sealant as recommended in writing by sealant manufacturer.

3. Contractor shall coordinate installation of perimeter sealant and backing materials between assemblies and adjacent construction in accordance with requirements of Section 07 92 13 – Elastomeric Joint Sealants.

4. Seal locations necessary to create and secure continuous enclosure even though Drawings may not indicate locations to be sealed.

5. Seal joints to prevent migration of water vapor or air to interior of building.

I. Glazing:

1. Glazing gaskets and sealant shall be installed in accordance with manufacturer written instructions without exception, including surface preparations.

2. “Anti-walk” edge blocking shall be utilized on vertical edges of glazing.

3. Refer to Section 08 81 00 – Glass Glazing for additional requirements.

3.06 CLEANING

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, aluminum windows and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the manufacturer's written instructions.

C. Aluminum windows shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required and retest until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When aluminum window Work is completed, remove unused materials, containers, and equipment, and clean the Site of aluminum window debris.

END OF SECTION

SECTION 08 71 00 – DOOR HARDWARE

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Door hardware

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

Americans with Disabilities Act (ADA)	
ADAAG	Americans with Disabilities Accessibility Guidelines
American National Standards Institute (ANSI)	
ANSI A 117.1	Accessible and Usable Buildings and Facilities
ANSI A 156.1	Butts and Hinges
ANSI A 156.3	Exit Devices
ANSI A 156.4	Door Controls – Door Closers
ANSI A 156.5	Auxiliary Locks and Associated Products
ANSI A 156.6	Architectural Door Trim
ANSI A 156.7	Template Hinge Dimensions
ANSI A 156.8	Door Controls – Overhead Stops
ANSI A 156.13	Mortise Locks and Latches
ANSI A 156.15 -	Closer Holder Release Devices
ANSI A 156.16	Auxiliary Hardware
ANSI A 156.18	Material and Finishes
ANSI A 117.1	Accessible and Usable Buildings and Facilities
Builders' Hardware Manufacturers' Association (BHMA)	
Building Code	

	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code
Door and Hardware Institute (DHI)	
	Recommended Procedure for Processing Hardware Schedules and Templates” and “Architectural Hardware Scheduling and Format.
National Fire Protection Association (NFPA)	
NFPA 80	Fire Doors and Windows
NFPA 101	Life Safety Code
Underwriters’ Laboratories (UL)	
UL 10B	Standard for Fire Test Door and Assemblies
UL 10C	Positive Pressure Fire Tests of Door Assemblies

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certificates:

1. Certification by the door hardware Manufacturer that the door hardware provided is suitable for, and compatible with, the required installation.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer’s products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of supplier’s qualifications demonstrating compliance with the qualifications requirements indicated.

4. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

5. Submit certification from a recognized testing agency that fire doors have passed tests to meet fire ratings indicated.

6. Certification for hardware in fire rated openings indicating compliance with UL 10C and the Code.

7. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Furnish a complete, detailed hardware schedule. The hardware schedule shall indicate groups, type, style, function, Manufacturer's name, catalog number, location, and finish of each item to be provided, in accordance with the DHI "Architectural Hardware Scheduling Sequence and Format." The hardware schedule shall include the following additional information:

a. List each door opening, organized into "hardware sets" indicating complete designations of every item required for each door opening to function as intended.

b. Location of each hardware set cross-referenced to floor plans and schedules on the Drawings.

c. Door sizes shall be noted on the hardware schedule, and hardware shall be in strict accordance with height, width, and thickness requirements.

d. Special mounting instructions or requirements that vary from standard.

e. Handing and degree of swing of each door.

f. Keying information.

g. Fastenings and other pertinent information.

h. Explanation of all abbreviations, symbols, and codes contained in schedule.

i. The hardware schedule shall also include a complete template list showing template references and data for each item requiring preparation of doors and frames.

j. Submit separate detailed keying schedule for approval indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

D. Samples:

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Door hardware shall be provided by a single Manufacturer, each.

B. Qualifications:

1. Manufacturers:

a. Door hardware Manufacturer shall have a minimum of 20 years of door hardware manufacturing experience.

b. Door hardware Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

c. Manufacturers without these qualifications will not be accepted.

2. Suppliers:

a. Supplier shall be a recognized architectural door hardware supplier who has maintained an office and has been furnishing hardware in the project's vicinity for a period of at least 2 years.

b. Supplier shall employ at least one Architectural Hardware Consultant (AHC) who shall be responsible for the preparation and execution of the Work of this Section and who shall be available to the Owner, the Engineer, and the Contractor during business hours for consultation about the project's hardware and requirements.

c. Supplier shall be a certified direct distributor and be a full sales and service organization for the Manufacturers proposed.

d. Suppliers without these qualifications will not be accepted.

3. Installers:

a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

b. Installer shall be trained, certified, and authorized by the Manufacturer to install the Manufacturer's product.

c. Installers without these qualifications will not be accepted.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's written warranty to cover defects in materials, products, and manufacturing workmanship. The term of the warranty shall be as indicated below:

a. Mortise Locksets: 5 years.

b. Exit Devices: 5 years.

c. Door Closers: 10 years.

2. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Door hardware shall be recommended by the Manufacturer for the installation indicated.

B. Door hardware shall be suitable for, and compatible with, the required installation.

C. Door hardware shall be best grade, entirely free from imperfections in manufacture and finish. Qualities, weights, and sizes specified herein are the minimum that will be accepted.

D. Hand of door shall be as indicated. If door handing changes prior to fabrication, the Contractor shall make necessary adjustments at the direction of the Engineer.

E. The Work hereunder shall include fabrication and mounting templates as needed for fabricators and for control of application of hardware items.

1. In addition thereto, the Contractor shall provide trim, attachments, and fastenings indicated or required for proper and complete installation.

F. Door hardware shall be coordinated with other Work requiring door hardware or attaching to it. Copies of schedules, templates, etc., shall be furnished in ample time to avoid fabrication and construction delays. Each item of hardware shall be identified according to the approved list and schedule. Hardware shall be made to template.

G. The Contractor shall furnish the hardware supplier with Shop Drawings from other trades with which hardware must be coordinated. After checking these Shop Drawings, the Contractor shall promptly supply necessary template information to all concerned as may be required to facilitate the progress of the job.

1. Furnish all templates and schedules required by the Manufacturers of the doors and frames to enable the Manufacturers to make proper provision in their Work to receive the door hardware. All locks, lock strikes, and flush bolts shall be made to ANSI standard dimensions.

2. Procedures for template information shall be in accordance with the handbook, “Recommended Procedure for Processing Hardware Schedules and Templates.”

2.02 FIRE RATED OPENINGS

A. Hardware furnished in connection with doors bearing UL Labels or where necessary to meet special requirements shall be in strict accordance with the Code and shall be subject to approval of the authority having jurisdiction.

B. Provide door hardware for fire-rated openings that comply with NFPA 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed by Underwriters Laboratories Inc. (UL) for use on types and sizes of doors indicated.

1. UL labeled doors shall have UL approved hardware, except that hinges that are not UL approved shall have a melting point greater than 2,000 deg F.

2. Certifications of compliance shall be made available to the Authority Having Jurisdiction upon request.

C. Door assemblies and components shall be compliant with positive pressure and S-label requirements. Door hardware shall be coordinated with door Manufacturers to ensure that total opening installation is compatible with UL 10C and the Code.

2.03 HINGES

A. Manufacturer or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. McKinney.

b. Pemko.

B. Description:

1. Hinges shall conform to ANSI A 156.1/BHMA A 2111 and shall be 5-knuckle design, heavy weight (0.180-in minimum), ball bearing type, with flush tips.

2. Two hinges shall be provided for each door leaf up to and including 5-feet (1.5 m) in height and an additional hinge shall be added for each 2½-feet (.76 m) or fractions thereof of additional door height.

3. Hinges shall be 4½ in by 4½-in, except at doors exceeding 36-in in width.

    a. Doors exceeding 36-in in width shall have 5-in by 4½-in hinges.

4. Hinges on exterior doors shall be provided with non-removable pins (NRP).

5. Provide hinges with countersunk, Phillips flat-head screws unless otherwise indicated.

2.04 CYLINDERS AND KEYING

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

    a. Sargent, Signature High Security Cylinders

B. Description:

1. Locks and cylinders shall be master keyed to the Owner's requirements as directed by the Engineer.

2. The Contractor shall have the hardware supplier submit a keying schedule for approval prior to placing an order for the locks and keying of cylinders. The keying schedule shall be coordinated between the Owner, the Engineer, the Contractor, and the hardware supplier.

C. Keying:

1. Locks and cylinders shall be construction master-keyed. Locks and cylinders to be master-keyed or grandmaster-keyed as directed by the Owner. The factory shall key locks and cylinders. Furnish the following key amounts:

    a. 2 change keys per lock.

    b. 3 grand master keys.

    c. 6 master keys per master level.

    d. 6 construction/temporary keys.

2. Master keys and all high-security or restricted keyway blanks shall be sealed in tamper-proof packaged boxes when shipped from the factory. The boxes shall be shrink-wrapped and imprinted to ensure the integrity of the packaging.

2.05 SURFACE MOUNTED OVERHEAD CLOSERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sargent 351 Series.

B. Description:

1. Closers shall be ANSI A 156.4, Grade 1 Certified.

2. Closers shall have non-ferrous covers, one-piece, aluminum alloy bodies forged steel arms, and separate valves for adjusting and backcheck, closing and latching cycles, and adjustable spring to provide up to 50 percent increase in spring power.

3. Closers shall be furnished with parallel arm mounting on doors and shall be mounted to permit 180-degree door swing wherever wall conditions permit. Furnish without hold open arms unless otherwise indicated. Closers shall not be installed on exterior or corridor side of doors; install closers on door unless otherwise approved in writing by the Engineer.

4. Closers shall be powder coated to match door hardware with a special rust inhibitor (SRI) pretreatment, as recommended in writing by the Manufacturer, applied prior to the powder coating.

5. Where closers or other items have lever or similar arms, attachment to doors shall be with sex bolts only.

6. Closers for out-swinging exterior doors shall be top-jamb-mounted and furnished with adapter plates.

7. The Contractor shall be responsible to provide the correct arm with the closers.

8. Closers shall be provided with sex bolts for fastening through doors, frames and transoms.

2.06 MORTISE LOCKSETS AND LATCHSETS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sargent 8200 Series.

B. Description:

1. Locksets shall be ANSI A 156.13 Series 1000 Grade 1. Functions shall be manufactured in a single sized case formed from minimum 12-gauge steel. Lockset shall have a field-adjustable, beveled armored front, with a 0.125-in (3.2 mm) minimum thickness and shall be reversible without opening the lock body. The lockset shall be 2 ¾-in backset with a one-piece ¾-in anti-friction stainless steel latchbolt. The deadbolt shall be a full 1-in throw made of stainless steel and have two hardened steel roller inserts. To ensure proper alignment, all trim, shall be thru-bolted and fully interchangeable between rose and escutcheon designs.

2. Function of locksets shall be appropriate for doors use. Hardware supplier shall verify lock functions with the Owner and the Engineer prior to ordering material.

3. Lock strikes shall be non-handed, boxed type of sufficient length and having curved lips to protect the trim and jambs and be so shaped as to avoid the possibility of tearing clothing. Strikes shall be provided with metal strike boxes.

4. Locks shall be provided with the same cylinder and keyway for master keying. They shall be the product of the same Manufacturer as the locksets unless otherwise indicated. The correct cylinders with necessary modifications and components such as cams, collars, rings, retainers, plates, fasteners, etc., shall be provided for other specialty hardware such as exit devices, store front locksets, and sliding door locks where the hardware manufacture specified is different than cylinder Manufacturer.

5. Exit doors shall be openable at all times from the inside without the use of key or any special knowledge or effort.

2.07 STRIKES

A. Manufacturer:

1. To be provided by exit device and lockset and latchset device Manufacturer.

B. Description:

1. Strikes shall be compatible with the installation required.

2. All strikes shall be non-handed with a curved lip.

2.08 EXIT DEVICES

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Sargent, 80 Series.

B. Description:

1. Exit devices shall be certified to meet ANSI A 156.3 Grade 1.

2. Exit devices shall be listed by Underwriters Laboratories and shall bear the UL label for life safety in full compliance with NFPA 80 and NFPA 101.

3. Mounting rails shall be formed from a solid single piece of stainless steel, brass, or bronze no less than 0.072-in thick. Push rails shall be constructed of 0.062-in thick material. Painted or anodized aluminum shall not be considered heavy duty and are not acceptable. Hex key dogging shall be standard for all life safety panic hardware. Lever trim shall be available in finishes and designs to match that of the specified locksets.

2.09 LOCK GUARDS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

B. Description: Provide high security, corrosion resistant, surface mounted lock guards with concealed fasteners compatible with the installation, at each exterior door.

2.10 DOOR TRIM AND PROTECTIVE PLATES

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

    b. Pemko.

B. Description:

1. Kickplates shall be 0.050-gauge, 2-in less width of door, beveled on 3 sides, and 10-in high, except where necessary to clear a louver in which case they shall be 8-in high.

2. Push plates, pull plates, door pulls, and miscellaneous door trim shall be as indicated.

2.11 WALL MOUNTED DOOR STOPS

A. Manufacturer, or Equal:

1. 1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

B. Description:

1. Where a door is indicated to open against a wall, wall mounted doorstops, in the form of wall bumpers, shall be provided. Provide convex or concave design as indicated.

2. Wall mounted doorstops shall be non-ferrous, and of the type given in the hardware schedule.

3. Provide door stops with the proper fasteners, as required by the substrate to which stops are to be secured.

2.12 OVERHEAD STOPS WITH HOLD OPEN FUNCTION

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal:

    a. Rixson.

B. Description:

1. Overhead type door holders shall be of correct size for door, 90 degree openable and allowing for checkmating. Interior doors shall be provided with overhead stops if wall type stops cannot be used.

2. Track, slide, arm, and jamb bracket shall be constructed of extruded bronze and shock absorber spring shall be of heavy tempered steel.

3. Overhead stops shall be of non-handed design.

2.13 WEATHERSTRIPPING, GASKETING AND SEALS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

    b. Pemko.

B. Description:

1. Provide continuous weatherseal on exterior doors.

2. Provide continuous light or sound seals on interior doors where indicated.

3. Provide UL rated fire and smoke seals on all fire rated doors. Provide intumescent seals as required to meet UL 10C and the Code. Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by Manufacturer.

2.14 THRESHOLDS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

    a. McKinney.

    b. Pemko.

B. Description:

1. Provide threshold at each exterior door, and at other locations where indicated. Provided in size and configuration indicated, fabricated to accommodate door hardware and to fit door frames.

2. Thresholds shall be aluminum unless otherwise noted.

3. Threshold units shall comply with ADAAG and ANSI A 117.1.

4. At Fire Rated doors, provide UL rated thresholds.

5. Where adjacent floor material differs, provide threshold as appropriate.

6. Provide marble threshold at toilet rooms.

2.15 SILENCERS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal:

a. McKinney.

b. Pemko.

B. Description: Interior door frames shall be provided with rubber silencers, 3 for each single door and 2 for each pair of doors.

2.16 FASTENERS

A. Provide necessary screws, bolts, and other fasteners of suitable size and type to secure the hardware into position. The fasteners shall match the hardware in material and finish.

B. The hardware provided, such as expansion bolts, sex bolts, toggle bolts and other approved anchorages shall be coordinated with the job and to each setting condition.

C. Phillips head screws shall be used at exposed conditions. Machine screws shall be used at metal doors and frames.

D. Required screws shall be supplied as necessary for securing door hardware in the appropriate manner. Thru-bolts shall be supplied for exit devices and door closers where required by the Code and where the appropriate blocking or reinforcing is not present in the door to preclude their use.

2.17 FINISHES

A. Door hardware shall be 630/US 32D (stainless steel satin finish) unless otherwise indicated.

B. The designations used in schedules and elsewhere to indicate hardware finishes are those listed in ANSI A 156.18 including coordination with traditional U.S. finishes shown by certain Manufacturers for their products.

C. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with Manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Locks, exit devices, door closers, overhead door holders, hinges, kickplates, pulls and push plates, thresholds, and other similar items shall be individually packed in separate, suitable, original, containers as furnished by the hardware Manufacturers. Each container shall be clearly marked with item numbers, article numbers, and names corresponding to those listed in the hardware schedule.

    a. Small miscellaneous items that would not require specific location identifications, such as wall mounted stops and silencers may be quantity packed if properly labeled with item numbers and other identification.

2. The Contractor shall check the hardware upon delivery with the aid of a representative of the hardware supplier’s firm.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer’s written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer’s written instructions for environmental conditions before, during, and after installation.

1. The Contractor shall make certain that the building is secured and free from weather elements prior to installing interior door hardware.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where door hardware will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed door hardware.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of door hardware. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, ADAAG, ANSI A 117.1 and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

1. Mount hardware units at heights indicated in the following applicable publications, except as specifically indicated or required to comply with the governing regulations.

a. The Contractor shall comply with DHI recommended locations for hardware as applicable for specified doors.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing Work specified in the Division 9 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, door hardware and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Adjusting and cleaning shall consist of ensuring smooth operation, lubricating and testing the door hardware.

1. Door hardware shall operate smoothly, quietly, and without squeaking and binding.

a. The Contractor shall adjust and check each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.

b. Latches and bolts shall be installed to automatically engage in keepers, whether activated by closers or by manual push. In no case should additional manual pressure be required to engage latch or bolt in keepers.

c. Closers and hinges shall be carefully adjusted to operate the doors noiselessly and evenly, and hinges shall be installed so as not to bind. Closers, closer arms, and hold-open arms shall be attached with sex bolts.

d. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

D. Door hardware shall be protected from damage from subsequent construction operations.

E. The Contractor shall make adjustments required and retest until accepted.

F. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

G. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

H. When door hardware Work is completed, remove unused materials, containers, and equipment, and clean the Site of door hardware debris.

I. The hardware Supplier shall do a final inspection prior to Substantial Completion to ensure that all hardware has been correctly installed and is in proper working order and shall provide a written report of this inspection to the Engineer the file.

3.07 HARDWARE SCHEDULE

A. The following schedule is furnished for whatever assistance it may afford the Contractor. The Contractor shall not consider it as entirely inclusive. Should any particular door or item be omitted in any scheduled hardware group, the Contractor shall provide door or item with hardware same as required for similar purposes as accepted by the Engineer, and at no additional cost to the Owner. Quantities listed are for each pair of doors, or for each single door.

B. Abbreviations:

1. BO – By Others.

2. KX – Knox Company.

3. MC – McKinney.

4. RX – Rixson.

5. SA – Sargent.

6. PMD – painted to match door.

7. W/SS – with security studs.

C. Hardware Schedule:

1. IS – Single Interior Doors (Office):

Quantity	**Device**	**Description**
Per Spec.	Hinges	
1	Lockset F05 (classroom)	
1	Closer	
Per Spec	Continuous Sounds Seals	
2	Kickplate	
1	Threshold (where indicated)	Pemko 151 A Mill Aluminum

2. TR – Interior Single Doors (Toilet Room):

Quantity	**Device**	**Description**
Per Spec.	Hinges	
1	Lockset (F22)	

1	Closer	
Per Spec.	Continuous Sounds Seals	
2	Kickplate	
1	Threshold	Marble, See Details

3. ES – Single Exterior Doors:

Quantity	**Device**	**Description**
Per Spec.	Hinges	
1	Exit Device (ANSI 08)	8313 ET
1	Closer	
1	Kickplate	
1	Threshold	Pemko 2005AV Mill Aluminum
1	Weatherstrip/Gasketing	Pemko S88D at Head and Jambs
1	Door Top Drip	Pemko 346 at Door Head
1	Door Bottom	Pemko 321DN Annodized Aluminum

END OF SECTION

SECTION 08 81 00 – GLASS GLAZING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Glass and glazing accessories.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures
08 11 13	Hollow Metal Doors and Frames

D. Reference Standards

ASTM International (ASTM)

ASTM C 1036	Flat Glass
ASTM C 1048	Heat Treated Flat Glass, Kind HS, FT Coated and Uncoated Glass
ASTM E 2190	Standard Specification for Insulating Glass Unit Performance and Evaluation

Building Code

Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code

Glazing Association of North America (GANA)

Insulating Glass Certification Council (IGCC)

National Fire Protection Association (NFPA)

Underwriters’ Laboratories (UL)

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, maintenance instructions, and the following:

    a. Step-by-step glass, glazing, setting, and sealing procedures.

    b. Manufacturer’s full-range color charts, indicating custom color for color selection by Engineer.

B. Certificates:

1. Certification of compliance with the requirements of paragraph 2.1.A.

2. Certified copies of recent test reports of systems similar to the design for this project substantiating performance of system in lieu of re-testing. Other supportive data shall be included as necessary.

3. For insulating glass units, furnish CBA certification from the IGCC.

4. Certification that the glazing materials have been tested in accordance with the ASTM test methods indicated.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Shop Drawings shall indicate thickness, dimension, U-values, R-values, and related data.

3. Include detail glazing methods, framing, and tolerances to accommodate thermal movement.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer’s name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 12-in by 12-in samples of each glass type.

3. 12-in by 12-in samples of each laminated panel type.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Glass shall be provided by a single Manufacturer.

2. Accessories shall be provided by a single Manufacturer, each.

B. Qualifications:

1. Manufacturers:

a. Glass Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

3. Certifications:

a. Insulating glass units shall be certified for compliance with seal classification "CBA" by the Insulating Glass Certification Council (IGCC) and tested in accordance with the ASTM test methods indicated.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Glass: Furnish Manufacturer's 10-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover the installation and associated labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Glazing products, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Glazing shall be recommended by the Manufacturer for the installation indicated.

C. Glazing and accessories shall be suitable for, and compatible with, the required installation.

D. The Contractor shall coordinate color samples with other Sections through the submittal process.

2.02 ACCEPTABLE MANUFACTURERS:

A. Subject to the requirements indicated, provide Manufacturer and product listed below:

1. Viracon, VE4-55

2. Vitro Architectural Glass

3. AGC Glass Company

2.03 ARCHITECTURAL GLASS

A. Each piece of glazing shall bear the Manufacturer's label showing the strength, grade, thickness, type and quality of the material. Labels shall remain in place until the glass has been set and inspected by the Engineer except that safety and insulating glass shall have permanently etched labels.

B. When material is not cut to size by the Manufacturer and is furnished from local stock, the glass and glazing Contractor shall submit an affidavit stating the strength, grade, thickness, type, quality, and Manufacturer of the material furnished.

C. Float glass and annealed glass shall conform to ASTM C 1036, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing, and light-reducing), and Quality q3.

D. Heat treated glass shall conform to ASTM C 1048, Type 1, Class 1 (clear) or Class 2 (tinted, heat-absorbing, and light-reducing), and Quality q3, Kind HS/FT.

1. Heat-treated flat glass shall be by horizontal (roller hearth) process with inherent rollerwave distortion parallel to the bottom edge of the glass as installed.

2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements.

3. For uncoated glass, comply with requirements for Condition A.

4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).

5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is required, including, but not limited to glass in doors, and glass in lites adjacent to doors.

6. In addition to conforming to ASTM C 1048, heat treated glass shall conform to flatness tolerances indicated below:

    a. Bow and warp are defined as deviation of a glass surface from a true plane, with glass freestanding or installed in a frame and positioned in a vertical plane. Localized bow refers to any straight-line segment on a glass surface with length of 12-in. Overall bow refers to any straight-line segment on glass surface that extends between opposite edges and is perpendicular to at least one edge. Length of line segment is gauge length. Localized bow shall not exceed 0.0625-in. Overall bow shall not exceed: 0.041-in per foot for gauge length zero to 36- in; 0.031-in per foot for gage length 36-in to 60-in; one half of the values listed in ASTM C1048-97b, Table 2 for gauge lengths exceeding 60-in. Where heat-treating results in parallel ripple or waves, maximum peak-to-valley deviation shall not exceed 0.003. Requirements for localized bow and overall bow shall also be satisfied. Direction of ripples shall be consistent throughout the installation.

7. Insulating glass units shall be Insulating Glass Certification Council certified and shall meet ASTM E 2190.

    a. Insulating glass units shall be permanently and hermetically sealed together at edges with continuous spacers, and dual sealant to maintain a factory dehydrated air space.

        1) Provide dual perimeter seal, inner (primary) seal of polyisobutylene butyl, and outer (secondary) seal of structural silicone.

    b. Provide aluminum spacer between lights with folded and permanently joined corners as approved to provide continuity around perimeter of each unit. Primary seal shall completely cover sides and corners of spacers between spacers and glass, both sides.

    c. Lites shall be separated by an aluminum spacer with 3 bent corners and one keyed-soldered corner, or 4 bent corners and straight butyl injected zinc plated steel straight key joint, to provide a hermetically sealed and dehydrated air space.

    d. Provide approved molecular sieve, silica gel, or blend of both for desiccant, sealed into spacers.

2.04 INSULATED GLASS

A. Tinted, thermal insulating units with low emissivity (Low-E) coating.

B. Insulating glass units shall be 1-in thick, comprised of 2 lites of HS float glass, except provide FT glass where required by the Code, including but not limited to glass installed in, or adjacent to, doors.

C. Lites shall be ¼-in thickness each, with ½-in air space.

D. Tentative color selection:

1. Outer lite: Bronze.

2. Inner lite: Clear.

3. The Engineer reserves the option of changing this tentative color selection during the submittal process.

E. Low Emissivity (Low-E) Coating shall be applied to the number 2 surface of thermal insulating glass units.

F. Light Transmittance: 27 percent.

G. SHGC: 0.38, max.

H. U-value: 0.26 btu/hr-ft deg F, max.

2.05 INTERIOR GLASS (Non-Fire Rated Openings):

A. Description:

1. Acoustical insulating units, thickness as indicated, comprised of 2 clear liters, FT glass.

2. 1 1/16-in total thickness, comprised of one lite ¼-in thick, one lite 5/16-in thick, with 1/2-in air space.

a. Sound Transmission Class (STC): 40

2.06 INTERIOR GLASS (Fire Rated Openings):

A. Description:

1. 1/4-in thick, clear-polished diamond welded wired glass, UL Listed.

2. Glass shall be compatible with the requirements indicated in Section 08 11 13 – Hollow Metal Doors and Frames.

2.07 ACCESSORIES

A. Glazing compound for non-fire rated glazing shall be Dow, 999-A Glazing Silicone, or equal.

1. Glazing compound shall be acetoxy cure silicone for adhesion to glass and metals. One-part sealant that cures in the presence of atmospheric moisture to produce a durable and flexible glazing and curtainwall seal.

B. Glazing compound for fire rated glazing shall be Dap 33, or equal.

1. Glazing compound shall meet the Code, and NFPA requirements for a hard-setting glazing compound with 90 percent inert and non-flammable components.

C. Glazing Tape shall be Tremco, No. 440, or equal.

1. Glazing tape shall be compatible with the glazing compound.

D. Setting blocks shall be 85 +/-, 5 durometer and spacer blocks, 50 durometer, shall be closed cell neoprene.

E. Additional material to complete glazing installation shall be as recommended in writing by the Manufacturer.

F. Seals against moisture intrusion as recommended by the Manufacturer. Provide with polyurethane and silicone-based sealants with a 20-year life.

2.08 FABRICATION

A. The Contractor shall field verify size, location, and placement of glazing, shall advise Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Glass shall be assembled before shipment to the Site.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer’s written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer’s written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where glazing and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed glazing

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of glazing. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate the Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION – GENERAL

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as determined by the Engineer.

B. The Contractor shall provide for a complete installation. Glazing shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. Glazing shall be performed in accordance with the GANA standards.

D. Frame elements shall have been painted where required and shall be thoroughly cleaned before glazing commences.

E. Separate dissimilar metals using gasketed fasteners and blocking to eliminate the possibility of electrolytic reaction.

3.06 INSTALLATION OF EXTERIOR GLAZING – GASKET SYSTEM

A. Glaze per Shop Drawings using gaskets and appurtenances furnished with the system. Provide setting blocks as required.

3.07 INSTALLATION OF EXTERIOR GLAZING – NON-GASKET SYSTEM

A. Set tape 1/8-in down from top of fixed bead.

B. Run a bead of approved gun-grade sealant from base of tape to bottom of glazing pocket leaving weep holes, where provided, free of sealant.

C. Place setting blocks, insert glass and press against tape and sealant until continuous perimeter contact is made.

D. Run a heel bead of approved sealant along exposed edge of glass.

E. Apply glazing bead.

F. Install spacer blocks between glazing bead and glass.

G. Run a continuous finish bead of sealant to fill voids above spacers on interior side and to fill void above tape on exterior side.

3.08 INSTALLATION OF INTERIOR GLAZING – NON-FIRE RATED OPENINGS

A. Install continuous glazing strip against rabbet.

B. Set glass in place on setting blocks and install another continuous glazing strip around perimeter of glass.

C. Install glazing beads, setting against glazing strips firmly in order to place a small amount of pressure against the strips.

3.09 INSTALLATION OF INTERIOR GLAZING – FIRE RATED OPENINGS

A. Bed glazing rabbet in hard-setting compound.

B. Set glass in place on setting blocks.

C. Face glass in the same compound and set beads.

D. Tool compound flush and full between glass and metal surrounds, adding compound as required.

3.10 CLEANING

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, glazing and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Clean glazing compound from frames around glazing installed under this Section upon completion of the Work.

3. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

4. Weep holes and drainage channels must be unobstructed and free from dirt and sealant.

C. Glazing shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required and retest until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When glazing Work is completed, remove unused materials, containers, and equipment, and clean the Site of glazing debris.

END OF SECTION

SECTION 08 91 00 – LOUVERS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. The Contractor shall provide louvers and appurtenant Work, complete, in place, and operational in accordance with the Contract Documents.

2. The Contractor shall furnish professional design and engineering services as required for louvers.

   a. Professional design and engineering services may be provided by the Manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

3. The Contractor shall coordinate color samples with other Sections through the submittal process.

4. The Contractor shall coordinate the requirements herein with the building heating, ventilating, and cooling system; see Division 23 Sections of these Specifications.

5. The Contractor shall coordinate wiring requirements and current characteristics of motor operators with the building electrical system; see Division 26 Sections of these Specifications.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

C. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

D. Reference Standards

Air Movement and Control Association (AMCA)	
Standard 500	Test Methods for Louvers, Dampers and Shutters
Standard 511	Certified Ratings Program for Air Control Devices
American Architectural Manufacturer's Association (AAMA)	
AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels

ASTM International (ASTM)	
AAMA 2605	Voluntary Specification, Performance Requirements, and Testing Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels
ASTM B 211	Aluminum and Aluminum-Alloy Bar, Rod, and Wire
ASTM B 209	Aluminum and Aluminum-Alloy Sheet and Plate
ASTM D 822	Standard Practice for Filtered Open Flame Carbon Arc Exposures of Paint and Related Coatings
ASTM D 2244	Standard Practice for Calculation of Tolerances and color Differences from Instrumentally Measured Color Coordinates
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code
Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA)	
	Architectural Sheet Metal Manual (ASMM)

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

   a. Performance data in accordance with AMCA Standards 500 and 511.

   b. AMCA licensed data demonstrating that each louver meets the criteria herein.

   c. Manufacturer’s full-range color charts, indicating custom color availability at no additional cost to the Owner, for color selection by the Owner.

   d. Certificates:

2. Certification by the louver Manufacturer, that the louvers provided are suitable for, and compatible with, the required installation.

3. Certification of compliance with the requirements of paragraph 2.1.A.

4. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer’s products, and contact information of the consultant firm of record, general contractor and owner.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

6. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

B. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional civil engineer licensed per local engineering licensing laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each louver type, schedule of louvers, location and installation requirements for hardware, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim. Shop Drawings shall show installation conditions at openings with various wall thickness and materials.

a. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each louver type.

C. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer’s name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 3-in by 4-in color samples showing substrate, finish, and color.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Louvers shall be provided by a single Manufacturer, unless otherwise indicated.

B. Qualifications:

1. Manufacturers:

    a. Louver Manufacturer shall have a minimum of 20 years of louver manufacturing experience.

    b. Louver Manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

    c. Manufacturers without these qualifications will not be accepted.

2. Installers:

    a. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

    b. Installers without these qualifications will not be accepted.

3. Licensed Professionals:

    a. A professional civil engineer licensed per local engineering licensing laws shall design the louvers and connections to the structure.

C. Fabrication practices, construction details, and installation procedures shall conform to the practices of SMACNA as recommended in the ASMM, as applicable and as required.

D. Louvers shall bear AMCA Certified Ratings Seals for air performance and water penetration ratings

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's extended 20-year written warranty for the finish. Warranty shall include provisions for failures of the finish including, but not limited to, chalking, crazing, peeling, and fading.

    a. Finish coating shall not chalk in excess of 8 numerical ratings when measured in accordance with ASTM D 4214

    b. Finish color shall not change color or fade in excess of 5 NBS units as determined by ASTM D 2244 and ASTM D 822.

2. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Structural Requirements:

1. Louvers, including related assemblies, components, and attachment details shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

    a. Refer to Section 01 33 17– Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

B. Louvers shall be recommended by the Manufacturer for the installation indicated.

C. Louvers shall be suitable for, and compatible with, the required installation.

D. Design Requirements:

1. Louver system Manufacturer shall furnish the systems herein, including necessary custom modifications to meet the indicated requirements and to maintain the visual design requirements as approved by the Engineer.

2. Stationary components of louvers shall be of all-welded design.

3. Aluminum Sheet: ASTM B 209, Alloy 3003 and 5005 with temper as required for forming or as otherwise recommended by the metal producer to provide the required finish.

4. Aluminum Extrusions: ASTM B 211, Alloy 6063-T5, 6063-T6, or 6061-T6, unless otherwise indicated.

5. Supports, anchorage, and accessories shall be provided as required for complete assembly.

6. Perimeter conditions shall allow for installation tolerances, expansion and contraction of adjacent materials, and sealant Manufacturer's recommended joint design.

7. The Contractor shall not assume sealant and interior finishes contribute to framing member strength, stiffness, or lateral stability.

8. Assemblies shall be free from vibration harmonics, rattles, wind whistles, and noise due to thermal movement, thermal movement transmitted to other building elements, and wind pressure. Assemblies shall be free from loosening, weakening, or fracturing of attachments by components.

9. Attachment considerations are to take into account Site peculiarities and expansion and contraction movements so there is no possibility of loosening, weakening, or fracturing connection between units and building structure or between units themselves.

10. System shall drain any water entering system to the exterior of system.

11. Concealed fastening shall be provided.

12. Uniform color and profile appearance shall be provided at components exposed to view.

E. Expansion and Contraction Requirements: Louver systems shall accommodate expansion and contraction movement due to surface temperature differentials without causing buckling, stresses on adjacent Work, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other visual or technical detrimental effects.

2.02 COMBINATION DRAINABLE LOUVERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Combination wall louvers shall be Ruskin Model ELC 6375DAX.

B. Description:

1. Combination drainable louvers shall be adjustable type with drain gutter in each blade and downspouts/drainage channels in jambs and mullions. Stationary blades and adjustable blades shall be contained within a single 6-in louver frame. Adjustable Section shall include low leakage blade and jamb seals. Components (heads, jambs, blades, and mullions) shall be factory assembled by the louver Manufacturer. Waterstop at sill shall be factory caulked water tight.

2. Heads, sills, jambs, mullions, and sills shall be one-piece structural aluminum members with integral caulking slot and retaining beads. Material thickness shall be 0.125-in. Mullions shall be sliding interlock with internal drains. Blades shall be one-piece aluminum extrusions with gutters designed to catch and direct water to jamb and mullion drains. Compression gaskets shall be provided between bottom of mullion or jamb and top of sill to insure leak tight connections.

a. Continuous, 0.125-in thick perimeter angles of same material as louvers shall be provided for attachment on inside to adjacent construction. At louvers over 6-feet (1.8 m) wide, center vertical aluminum angle support and approved aluminum blade braces shall be provided, each blade. Secure top and bottom and to each brace and blade.

3. Frame: 6-in deep, 6063-T5 extruded aluminum, with .125-in nominal wall thickness. Downspouts/drainage channels and caulking surfaces shall be provided.

4. Blades: Front stationary drainage blades, 6063-T5 extruded aluminum with .081-in nominal wall thickness, positioned at 37½ degree angle and spaced approximately 6 1/8-in on center. Rear adjustable airfoil blades, 6063-T5 extruded aluminum, 0.140-in nominal wall thickness.

5. Motor Operator: Electric type furnished with louver, 120 volts max.

C. Performance Requirements:

1. AMCA Performance:

a. A 4 ft by 4 ft unit shall be licensed to bear the AMCA seal, and shall conform to the following:

Free Area	Minimum 7.48 sq. ft
Percent Free Area	Minimum 47 percent
Velocity at the Point of Beginning Water Penetration of 0.01 oz/sq. ft.	1169 FPM (.36 KPM)
Pressure Drop at the Point of Beginning Water Penetration	0.15-in water
Air volume	7,000 cfm

2.03 DRAINABLE STATIONARY LOUVERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Combination wall louvers shall be Ruskin Model ELF 6375DXH.

B. Description

1. Drainable stationary louvers shall have drain gutter in each blade and downspouts/drainage channels in jambs and mullions. Stationary blades shall be contained within a single 6 in louver frame. Components (heads, jambs, blades, and mullions) shall be factory assembled by the louver Manufacturer. Waterstop at sill shall be factory caulked water tight.

2. Heads, sills, jambs, mullions, and sills shall be one-piece structural aluminum members with integral caulking slot and retaining beads. Material thickness shall be 0.125 in. Mullions shall be sliding interlock with internal drains. Blades shall be one-piece aluminum extrusions with gutters designed to catch and direct water to jamb and mullion drains. Compression gaskets shall be provided between bottom of mullion or jamb and top of sill to insure leak tight connections.

a. Continuous, 0.125 in thick perimeter angles of same material as louvers shall be provided for attachment on inside to adjacent construction. At louvers over 6 ft wide, center vertical aluminum angle support and approved aluminum blade braces shall be provided, each blade. Secure top and bottom and to each brace and blade.

3. Frame: 6-in deep, 6063-T5 extruded aluminum, with .125-in nominal wall thickness. Downspouts/drainage channels and caulking surfaces shall be provided.

4. Blades: Stationary drainage blades, 6063-T5 extruded aluminum with .081-in nominal wall thickness, positioned at 37½ degree angle and spaced approximately 6 1/8 in on center.

C. Performance

1. AMCA Performance:

a. A 4 ft by 4 ft unit shall be licensed to bear the AMCA seal, and shall conform to the following:

Free Area	Minimum 9.08 sq. ft
Percent Free Area	Minimum 57 percent
Velocity at the Point of Beginning Water Penetration of 0.01 oz/sq. ft.	1023 FPM (312 MPM)

2.04 ACOUSTICAL LOUVERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

a. Louvers shall be Ruskin Model ACL 1245.

B. Description:

1. Louvers meeting the following specifications shall be furnished and installed where shown on the plans and/or as described in schedules. Louvers too large for complete factory assembly shall be built up by the installing Contractor from factory assembled Sections. Louver frames, mullions and Section joints shall be adequately supported from the building structure to withstand this wind loading.

2. Louvers shall be acoustical stationary Airfoil blade, fabricated from aluminum. Louver frame depth shall be 12 in. Acoustical material shall be fiberglass insulation. Blades and frames will be mechanically fastened together. Each louver shall be equipped with a framed, removable, rear-mounted screen of flattened expanded aluminum.

3. Comprehensive louver performance data including airflow resistance, water penetration, Sound Transmission Class (STC), Outdoor Indoor Transmission Class (OITC) and free area shall be submitted for approval. Louvers must be AMCA certified for airflow resistance and water penetration. Acoustical testing must be performed by an independent laboratory.

C. Performance:

1. AMCA Performance:

a. A 4 ft by 4 ft unit shall be licensed to bear the AMCA seal, and shall conform to the following:

Free Area	Minimum 3.49 sq. ft.
Percent Free Area	Minimum 22 percent
Velocity at the Point of Beginning Water Penetration of 0.01 oz/sq. ft.	1025 FPM (312 MPM)

2.05 FRP STATIONARY BLADE LOUVERS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal.

   a. Fixed Type FRP louvers shall be Composite Fan Technology, FRP Louvers, or equal.

B. Description:

1. Louvers shall be constructed of isophthalic polyester fire-retardant resin, equivalent to Hetron 99P polyester resin with a Class 1 flamespread of 25 or less.

2. Ultraviolet inhibitors shall be incorporated into the resin.

3. Louver sections shall include fiberglass unidirectional filaments and a synthetic veil.

4. Provide a minimum of 40 percent glass by weight.

5. Coloring shall be achieved by the use of pigments impregnated through the entire profile.

6. Louver frames shall be 6-in deep, of the channel type, and provided with a minimum thickness of ¼-in.

7. Louver blades shall be:

   a. Of a “K” style design.

   b. Provided with a minimum thickness of 1/8-in.

   c. Provided with a 45 degree opening.

8. Hardware shall be fabricated from Type 306 stainless steel.

9. Provide the following accessories:

   a. A 1/2-in mesh polyethylene screen mounted in a removable PVC frame.

   b. Fiberglass mullion covers.

C. Performance:

Free Area	Minimum 9.08 sq. ft.
Percent Free Area	Minimum 57 percent
Velocity at the Point of Beginning Water Penetration of 0.01 oz/sq. ft.	1023 FPM (312 MPM)

2.06 ACCESSORIES

A. Sill Extensions/Flashing:

1. Except for FRP stationary blade louvers, sill extensions/flashing shall be one-piece, extruded 0.060, aluminum.

    a. Sill extensions/flashing for FRP stationary blade louvers shall be one-piece fiberglass reinforced plastic to match the FRP louver.

2. Sill extension/flashing finish shall be the same as louver, custom color to match adjacent exterior wall, as approved by the Engineer.

B. Insulated Blank-Off Panels:

1. Insulated blank-off panels shall be provided where required to seal-off louver area not connected to ductwork or to cover areas not required for free air. Insulated blank-off panels shall be provided by the louver Manufacturer and shall consist of 2-in glass fiberboard insulation encapsulated and sealed completely in 0.032-in aluminum skins, securely fastened to louvers and ductwork.

2. Insulated blank-off panel finish shall be same as louvers, flat black in color, unless otherwise indicated.

C. Screens:

1. Bird Screen: Each exterior louver shall be provided with ¾-in by 0.051-in mesh aluminum wire bird screen secured within rewireable extruded aluminum frame as approved. Attach to interior face of louver, unless otherwise noted.

2. Insect Screen: For exterior louvers not connected to ductwork, provide separate fiberglass insect screen, frame, and accessories mounted to interior face of bird screen.

    a. Insect screen shall be installed such that it is removable to allow for frequent maintenance and cleaning.

3. Screens shall be secured to louver frames with removable machine screws, spaced at each corner and at 12-in on center, minimum, between corners

4. Screens and frames shall have same finish as louvers, color shall be black.

5. Fasteners: Fasteners shall be structural-grade aluminum. Provide materials, types, gauges, and lengths to suit unit installation conditions. Phillips flat-head machine screws shall be used for exposed features, unless otherwise indicated.

6. Anchor and inserts: Anchors and inserts shall be non-ferrous metal for exterior installations and elsewhere as required for corrosion resistance. Steel expansion bolt devices shall be used for drilled-in-place anchors. Concrete inserts shall be provided as required.

2.07 FINISH AND COLOR

A. Finish system shall be 1.2-mil, PVF2 Kynar 500, formulated by a licensed formulator to contain 70 percent PVF resin and applied by a licensed applicator.

1. The surface condition of this finish coat shall be 100 percent free of holidays, drip marks, scratches, roll marks, or abrasions that are visible from a distance of 5 ft in good light when in installed position. Surfaces shall be free of checking, crazing, peeling, or loss of adhesion.

2. Finish shall meet or exceed AAMA 2605.

3. Color shall be selected and approved by the Owner from Manufacturer's full color range including custom colors, and may be required to exactly match other building components, as determined by the Owner, at no additional cost to the Owner.

a. Tentative color selection: To be Selected.

b. The Owner reserves the option of changing this tentative color selection during the submittal process.

2.08 FABRICATION

A. The Contractor shall field verify size, location, and placement of louvers, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and Shop Drawings with fabrication and shop assembly to minimize field adjustments.

1. Louvers shall be assembled before shipment to the Site.

2. Accurate relation of planes and angles shall be maintained, with hairline fit of contacting members.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where louvers and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed louvers.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of louvers. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. The Contractor shall block and reinforce walls as required to support the louvers and appurtenances.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Sill extensions shall be provided at exterior louver installations.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, louvers and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Louvers shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required and retest until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When louver Work is completed, remove unused materials, containers, and equipment, and clean the Site of louver debris.

END OF SECTION

SECTION 09 29 00 – GYPSUM BOARD

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Gypsum board

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

D. Reference Standards

ASTM International (ASTM)	
ASTM A 36	Standard Specification for Carbon Structural Steel
ASTM A 653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 853	Standard Specification for Steel Wire, Carbon, for General Use
ASTM C 36	Standard Specification for Gypsum Wallboard
ASTM C 475	Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board
ASTM C 518	Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM C 578	Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation
ASTM C 630	Standard Specification for Water-Resistant Gypsum Backing Board
ASTM C 645	Standard Specification for Nonstructural Steel Framing Members
ASTM C 754	Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products
ASTM C 840	Standard Specification for Application and Finishing of Gypsum Board.
ASTM C 1002	Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

ASTM C 1325	Standard Specification for Non-Asbestos Fiber-Mat Reinforced Cement Substrate Sheets
ASTM C 1047	Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base
ASTM D 2626	Standard Specification for Asphalt Saturated and Coated Organic Felt Base Sheet Used in Roofing
ASTM D 3273	Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in and Environmental Chamber
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 96	Standard Test Method for Water Vapor Transmission of Materials
ASTM E 119	Standard Test Methods for Fire Tests of Building Construction and Materials
ASTM E 136	Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 1382 degrees F
ASTM E 1677	Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building Walls
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referenced herein as “the Code.”
Gypsum Association	
GA-201	Gypsum Board for Walls and Ceilings
GA-203	Installation of Screw-Type Steel Framing Members to Receive Gypsum Board
GA-214	Recommended Levels of Gypsum Board Finish
GA-216	Recommended Specifications for the Application and Finishing of Gypsum Board
GA-253	Recommended Specification for the Application of Gypsum Sheathing
GA-600	Fire Resistance Design Manual
Technical Association of Pulp and Paper Industry (TAPPI)	
Underwriters’ Laboratories (UL)	
	Fire Resistance Directory

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Samples:

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the manufacturer's warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Gypsum board shall be provided by a single Manufacturer, each.

2. Framing and accessories shall be provided by a single Manufacturer, each.

3. Tape, adhesives, joint and finishing compounds shall be provided by a single Manufacturer, each.

1.07 WARRANTY

A. Manufacturer Warranty

1. Furnish Manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

2. Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover labor.

3. Warranties shall be non-prorated for the entire warranty period.

4. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Gypsum board, framing, and appurtenances shall be recommended by the Manufacturer for the installation indicated.

B. Gypsum board, framing, and appurtenances shall be suitable for, and compatible with, the required installation.

C. Labeling and Certification: Fire rated materials shall bear testing agency labels and required fire classification numbers.

2.02 GYPSUM BOARD

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from one of the Manufacturers listed below, or equal.

a. GP Gypsum Corporation.

b. National Gypsum Company.

c. United States Gypsum Company.

B. Gypsum board shall comply with ASTM C 36.

C. Gypsum board shall be 5/8-in thick with rounded, tapered edges, unless otherwise indicated.

D. Gypsum board shall be fire rated “Type X,” unless otherwise indicated.

2.03 GYPSUM BOARD ACCESSORIES

A. Tape, joint compound, and finishing compound shall comply with ASTM C 475, and shall be compatible with the gypsum board, as recommended by the gypsum board Manufacturer.

1. Tape shall be fiberglass reinforcing tape.

B. Adhesives for fastening gypsum board-to-gypsum board shall be in accordance with the printed recommendations of the gypsum board Manufacturer.

C. Concealed sealant shall be mastic type, non-shrinking, non-drying, non-migrating, and non-staining, approved for use by the gypsum board Manufacturer.

D. Metal Accessories: Except as otherwise indicated, provide Manufacturer's standard galvanized steel beaded units with face flanges for concealment in joint compound, including corner beads, casing beads, control joints, and edge trim.

1. Provide additional special accessories and shapes as required.

E. Reinforcing for Applied Items:

1. Light-duty applications – minimum 14-gauge galvanized steel sheet attachment plate for toggle bolt applications, unless otherwise indicated.

2. Heavy-duty applications – ASTM A 36 galvanized steel in required thicknesses and shapes with required fasteners.

F. Fasteners shall be corrosion resistant coated complying with the referenced standards.

1. Screws shall be self-drilling, self-tapping, bugle head for use with power tools, length as recommended by Gypsum Association and the Code.

a. Type “S” for board-to-sheet metal application.

b. Type “G” for board-to-board application.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

1. Store in dry, well-ventilated space, protected from moisture and humidity.

C. Handle materials in strict accordance with Manufacturer’s written instructions.

3.02 PROJECT CONDITIONS

A. Comply with Manufacturer’s written instructions, referenced standards, for environmental conditions before, during, and after installation.

1. Building and areas receiving gypsum board Work shall be completely dried-in and adjoining materials shall be sufficiently dry before starting or continuing gypsum board installation.

2. All windows, doors, roofing, and other waterproofing and weather proofing cladding and components of the building shell shall in place and complete.

3. Gypsum board shall not be exposed to moisture, excessive or continuous humidity, or water at any time.

4. Maintain a minimum room temperature of 55 deg F, during application of gypsum board and joint treatment until completely dry or occupied.

5. Provide adequate ventilation as required.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where gypsum board, framing, and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed gypsum board.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.05 INSTALLATION – GENERAL

A. Installation shall comply with the requirements of the Contract Documents, with the requirements of the Code, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. Horizontal lines shall be level, and vertical lines shall be plumb.

E. Coordinate location of concealed supplemental blocking, backing, and additional anchoring reinforcement with items furnished under other Sections.

3.06 INSTALLATION – GYPSUM BOARD GENERAL

A. Install gypsum board to minimize joints. When joints are necessary, butt tapered joints together; end joints shall be avoided and kept to a minimum.

1. Boards shall be brought into contact with each other but shall not be forced into place. Joints on opposite sides of a partition shall not occur on the same stud.

2. Provide expansion joints as shown, as recommended per applicable references, and as directed.

B. Where gypsum board abuts other materials, such as masonry walls, structural frame, and decking, the gypsum board shall be held back so as to form a joint, which shall be sealed with acoustical or fire rated sealant as required for the condition.

1. Isolate edges of gypsum board 1/2-in from abutment with structure, particularly at slabs on grade. Provide trim and caulk with sealant.

C. Fasteners:

1. Gypsum board shall be screw-fastened to framing.

a. Screws shall be spaced not to exceed 12-in on center except at vertical butting edges of the fire-rated partitions where they shall be 8-in on center.

b. Space fasteners in accordance with applicable reference standards and Manufacturer's recommendations, except as otherwise indicated.

D. Single Layer Construction: Gypsum board shall be held in firm contact with framing member while fastenings are being driven. Fastening shall proceed from center portion of the gypsum board toward the edges and ends. Fasteners shall be set with heads slightly below the surface of the gypsum board in the dimple formed by the power screwdriver. Care shall be taken to avoid the breaking of the face paper of the gypsum board. Improperly driven screws shall be removed.

E. Metal Accessories:

1. Metal edge trim shall be provided whenever edge of gypsum board would otherwise be exposed or semi-exposed, at all discontinued edges, where abutting with another material, and where otherwise indicated or required.

2. Corner beads shall be provided at all exterior corners.

3. Metal accessories shall be set plumb, level, straight and true and shall be shimmed where necessary. The accessories shall be mitered at corners; exposed joints shall be accurately and tightly fitted. Sections shall be installed in lengths as long as practicable, and splices shall be held to a minimum.

4. Metal accessories shall be screw-fastened to framing members with screws spaced not more than 9-in apart.

5. Where feasible, use the same fasteners to anchor metal accessories as required to fasten gypsum board to framing.

F. Upon completion, gypsum board shall form a smooth, firm flat plane free from ripples, waves, buckles, bumps, and projecting edges.

3.07 GYPSUM BOARD FINISHING

A. Gypsum board shall be taped, and all screw heads, penetrations, joints, end trim, corner beads, fastener, and other depressions shall be treated with joint and finishing compounds applied per applicable references and per Manufacturer's printed recommendations for three-coat Work.

B. Finish gypsum Work in accordance with ASTM C 840, to Level 4 of Gypsum Association GA-214, and the following:

1. Joint compound shall be mixed in accordance with Manufacturer's instructions. A uniform layer of compound shall be applied over the joint approximately 4-in wide and filling the groove. The tape shall be centered over the joint and embedded into the compound leaving sufficient compound under tape to provide proper bond.

2. A second and third coat of joint compound or joint finishing compound shall be applied after each preceding coat has been allowed to thoroughly dry. Coats shall be spread over tape and the tapered portion of edge and feathered out at the edge.

3. All inside corners shall be coated with at least one coat of joint compound over perforated tape with the edges feathered out.

4. All screw head dimples shall receive at least three coats of compound.

5. Flanges of corner and casing beads shall be concealed by at least two coats of compound feathered out approximately 9-in on one or both sides of the exposed metal as applicable.

6. Allow each application of compound to joints and fastener heads to dry, then sand as required.

7. Caution shall be used to avoid roughing of the gypsum board paper. All gypsum board and treated areas shall be left smooth and ready for painting.

8. Gypsum board shall be sanded smooth, dusted, and provided with a textured orange peel finish coat.

9. Joints and penetrations in gypsum board at non-visible locations, such as within attics or in ceiling plenums shall receive joint treatment, shall be taped, and joints shall be caulked with sealant. Additional treatment to comply with the required fire ratings shall be provided.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Gypsum board shall be protected from damage from subsequent construction operations.

C. The Contractor shall make adjustments required until accepted.

D. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

E. When gypsum board Work is completed, remove unused materials, containers, and equipment, and clean the Site of gypsum board debris.

END OF SECTION

SECTION 09 30 13 – CERAMIC TILING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ceramic tile

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Building Code: Refer to the Drawings to determine which building code applies within a given jurisdiction. The applicable building code, defined by the Drawings, is referred to herein as “the Code.”

D. Reference Specifications

01 33 00	Submittal Procedures
07 92 13	Elastomeric Joint Sealants

E. Reference Standards

Americans with Disabilities Act (ADA):	
ADAAG - Americans with Disabilities Accessibility Guidelines	
American Society of Testing and Materials (ASTM):	
ASTM C241	Standard Test Method for Determining Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C503	Standard Specification for Marble Dimension Stone
ASTM C1028	Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
ASTM F2170	Standard Test Method for Determining Relative Humidity in Concrete Slabs using In Situ Probes
American National Standards Institute (ANSI):	
ANSI A108	Standard Specifications for the Installation of Ceramic Tile
ANSI A108.5	Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex Portland Cement Mortar
ANSI A108.10	Installation of Grout in Tile Work
ANSI A118.1	Dry-Set Cement Mortar

ANSI A118.4	Latex-Portland Cement Mortar
ANSI A118.7	Specification for Polymer Modified Tile Grouts for Tile Installation
ANSI A137.1	Standard Specification for Ceramic Tile
Marble Institute of America (MIA): Dimension Stone Design Manual IV.	
South Coast Air Quality Management District (SCAQMD):	
Tile Council of America (TCA): Handbook for Ceramic Tile Installation (CIT).	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

2. Tile Manufacturer's standard color charts for color selection by the Owner.

3. Grout Manufacturer's standard color charts for color selection by the Owner.

B. Warranty: Submit a copy of the warranty.

C. Certifications:

1. Certification by the tile Manufacturer that the tile materials provided are suitable for, and compatible with, the required installation.

2. Master Grade Certificate for each shipment, stating the grade, type, and composition of tile, identification marks for tile packages, and the name and location of the project.

a. The certificates shall be signed by the tile Manufacturer and installer and shall be issued when tile is shipped, before beginning any tile Work.

b. The certificate shall show that the tile, mortar, and grout complies with the requirements of the Tile Council of America Inc. (TCA).

c. Adequate information shall be included on the certificate for identifying corresponding shipping packages.

d. Include certifications and other data as may be required to show compliance with these specifications.

3. Certification of recycled content as required for select materials herein.

4. Independent certification that the products comply with the VOC limits and VOC performance criteria indicated.

5. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

6. Certification that the required substrate tests have been performed, and that the substrates are suitable for the installation.

D. Shop Drawings:

1. Complete shop drawings showing location and detail of installation.

2. Include details, tile layout, colors and pattern distribution.

3. Show ceramic tile control joints and demonstrate coordination with substrate control joint locations.

E. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. Panel sample of each tile type, showing specified finish and color, mounted on not less than 16-in square plywood or hardboard backing and grouted as required.

3. Sample palettes of each grout type, showing full color range. Each individual grout sample shall be 6-in long by 3/8-in wide.

4. Representative samples of specified marble thresholds, 6-in long by width indicated.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Certifications:

1. Tile shall be delivered with quality certificates of the Tile Council of America (TCA) and shall meet the Code requirements.

B. Single Source Responsibility:

1. Ceramic tile shall be provided by a single Manufacturer. Each color, grade, finish, type, composition, and variety of tile shall be obtained from a single production run.

2. Ingredients for each mortar, adhesive, and grout component shall be obtained from a single Manufacturer and each aggregate shall be from one source or producer.

3. Mortar and grout shall be provided from a single Manufacturer, each.

4. Shower receptors shall be provided from a single Manufacturer.

C. Qualifications:

1. Installers:

a. A minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

D. Tile Work shall be not less than standards and references established within the CIT by the TCA.

E. Tile installation shall conform to ANSI A108.5 as indicated for tile and ANSI A108.10 for grouting.

F. Mock-Ups:

1. Prior to installation, erect sample mock-up of the floor and wall tile using materials and details required for final Work. The panel shall be approximately 6 ft long by 4 ft high. The sample mock-up shall show the workmanship, joints, colors, layout and pattern of the ceramic tile.

2. The sample panel shall be erected in a location as designated by the Engineer.

a. The sample panel may be constructed as part of the Work, but must be constructed to the satisfaction of the Engineer prior to acceptance of the panel, and must be accepted prior to proceeding with the remainder of the Ceramic Tile Work.

b. If the sample mock-up is provided separate from the Work, retain mock-up during construction as a standard for judging completed Work. Do not alter, move, or destroy mock-up until Work is completed.

3. Obtain Engineer's acceptance of qualities of mock-up before installation. Modify and/or reconstruct sample mock-up at the direction of the Engineer until acceptance.

4. Acceptance of sample mock-up shall not relieve the Contractor from compliance with the Contract Documents.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Ceramic Tile: Furnish Manufacturer's 2 year written warranty to cover defects in materials, products, and manufacturing workmanship. The term of the warranty shall begin on the date of Substantial Completion.

1.08 EXTRA MATERIALS

A. Provide 1-square foot for each type of tile being provided for the Work for future maintenance and replacement. Provide extra materials separately packaged, identified, and left with the Owner.

B. Extra materials shall be provided from the same production run as the materials installed.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Design Requirements:

1. The Contractor shall coordinate color samples with other Sections through the submittal process.

B. Ceramic tile shall comply with ANSI A137.1.

C. Ceramic tile adhesives, sealants, and sealant primers shall be low VOC per SCAQMD Rule No. 1168.

2.02 CERAMIC TILE (WALL TILE)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements herein, provide products from the Manufacturer listed below, or equal.

a. DalTile Corporation, American Olean Bright Wall Tile, unless otherwise indicated.

B. Description:

1. Wall tile shall be 4 ¼-in square, 5/16-in thick, cushion edge, bright glaze (glossy).

2. Provide with required shapes such as cove base, bullnose, angle, and other trim items matching tile as required.

3. Provide in Color Group 1.

4. Installation shall be on concrete masonry units.

2.03 CERAMIC TILE (FLOOR TILE)

A. Manufacturer and Product, or Equal:

1. Subject to the requirements herein, provide products from the Manufacturer listed below, or equal.

    a. DalTile Corporation, American Olean Unglazed Ceramic Mosaic floor tile.

B. Description:

1. Toilet, Shower, and Locker Rooms: Floor tile shall be mosaic, 2-in square, ¼-in thick, cushion edge, unglazed vitreous tile.

2. Provide cove base as indicated for wall tile above.

3. Provide in Color Group 2.

4. Floor tile shall have the following characteristics:

Performance Characteristics	Mosaic floor tile
ASTM C1028 Coefficient of Friction (COF)	≥ 0.60 wet; ≥ 0.70 dry
Moisture Absorption	< 3.0 percent
Breaking Strength	>250lb
Abrasion Resistance	4

2.04 TILE COLOR GROUPS

A. Color of tile shall be as selected and approved by the Owner from Manufacturer's full color range.

1. Tentative color selection: The Owner reserves the option of changing this tentative color selection during the submittal process.

	Color Group 1	**Color Group 2**
Color A	Designer White 61	Storm Gray A40
Color B	Storm Gray 40	To Be Selected
Color C	Navy 117	To Be Selected

2. Final colors, pattern, and appearance shall be selected and approved by the Owner prior to installation.

2.05 MORTAR

A. Dry-set mortar (walls) shall conform to ANSI A118.1 and shall have the TCA hallmark.

B. Latex-Portland cement mortar (floors) shall conform to ANSI A118.4 and shall have the TCA hallmark.

2.06 GROUT

A. Polymer modified grout (walls and floor) shall conform to shall conform to ANSI A118.7.

B. Color of grout shall be as selected and approved by the Owner, prior to installation.

2.07 GROUT SEALER

A. Grout sealer shall be low VOC per SCAQMD Rule No. 1168, clear penetrating type, as recommended by grout Manufacturer.

2.08 MIX WATER

A. Water shall be fresh, clean, potable, and shall be free from organic matter, acids, and alkalis.

2.09 MARBLE THRESHOLDS

A. Marble thresholds shall comply with ASTM C503 and shall be classified Group A per definitions for soundness per MIA “Dimension Stone Design Manual IV.”

B. Coefficients of Friction (COF) for marble thresholds shall be as indicated above for floor tile. Marble abrasion shall be not less than 12.0 when tested in accordance with ASTM C241. Marble thresholds shall comply with 36 CFR 1191 for coefficient of friction for interior floors.

C. Marble thresholds shall be honed, solid marble, white color, in size, and configuration as indicated.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer’s written instructions.

3.02 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where tile will be installed for compliance with requirements for installation, taking into account tolerances, and other conditions affecting performance of installed tile.

    a. Substrates for setting tile shall be firm, sound, dimensionally stable, dry, clean, free from oil, waxy films, and curing compounds; and shall be within flatness tolerances required by referenced standards.

    b. Perform substrate humidity test in accordance with ASTM F2170. Comply with tile Manufacturer's written instructions to achieve acceptable relative humidity levels in the concrete slab prior to applying flooring materials. In no case should the humidity levels in the slab be greater than 75 percent, prior to applying materials.

    c. Installation of grounds, anchors, recessed frames, electrical and mechanical units of Work, and similar items located in or behind tile shall be completed before installing tile.

    d. Joints and cracks in tile substrates shall be coordinated with tile movement joint locations.

    e. For wall tile, maximum variation in tile substrate shall be 1/8-in from the required plane in 8 ft of wall.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions, TCA, and ANSI standards for environmental conditions before, during, and after application.

    1. Do not install tile until areas have been fully enclosed and environmental conditions have reached the levels indicated during occupancy.

    2. Maintain ambient temperature and humidity conditions during and after installation of tile at levels indicated during occupancy.

    3. Allow tile to reach room temperature or minimum temperature recommended by Manufacturer before beginning installation.

    4. Protect adhesives from freezing. Follow Manufacturer's recommendations for minimum temperatures to which adhesives are exposed.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 SURFACE PREPARATION

A. Surface preparation shall be in compliance with the referenced standards, and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials shall be removed by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

C. Where concrete substrates are indicated, provide latex-Portland cement mortars that comply with flatness tolerances in ANSI A108.

D. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

E. Trowelable leveling and patching compounds shall be used per tile Manufacturer's written instructions to fill cracks, holes, and depressions.

F. Immediately before application of tile materials, scrape surfaces to be covered free from foreign materials and brush clean.

G. Substrate shall be swept to remove all loose materials prior to beginning ceramic tile installation.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

B. Blending Tile: For tile exhibiting color variations within the ranges selected during sample submittals, The Contractor shall verify that tile has been blended in the factory and packaged so tile units taken from one package show the same range in colors as those taken from other packages and match approved samples. If not factory blended, tile shall either be returned to Manufacturer or blended at Site to the satisfaction of the Engineer before installing.

C. Jointing Pattern: Tile shall be laid in grid pattern, unless otherwise indicated. Joints shall be aligned when adjoining tiles on floor, base, walls, and trim are the same size. Tile Work shall be laid out with tile fields centered in both directions in each space or on each wall area. Align joints to give straight uniform grout lines, plumb, and level. Align floor joints to give straight uniform grout lines parallel with walls. Adjustments shall be made to minimize tile cutting. Uniform joint widths shall be provided, unless otherwise indicated. Make joints between tile sheets same width as joints within sheets, so that extent of each sheet is not apparent in finished Work.

D. Movement Joints:

1. Expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, shall be located where indicated during installation of setting materials, mortar beds, and tile. Joints shall not be saw-cut after installing tiles.

a. Joints shall be located in tile surfaces directly above joints in concrete substrates.

b. Joints shall be prepared and sealants shall be applied to comply with Section 07 92 13 - Elastomeric Joint Sealants.

E. Mortar and Grout Mixing:

1. Mortars and grouts shall be mixed to comply with referenced standards and to comply with mortar and grout Manufacturer's written instructions.

2. Materials, water, and additives shall be added in accurate proportions.

3. The Contractor shall use mixing equipment, mixer speeds, mixing containers, mixing time, and procedures to produce mortars and grouts of uniform quality with optimum performance characteristics.

F. Cut edges clean before installing tile. Fit tile carefully against trim, accessories, ground pipes, electric boxes, and other built-in fixtures so that escutcheons, plates, and collars will completely overlap cut edges.

3.06 INSTALLATION – WALL TILE

A. Installation shall comply with the requirements of the Contract Documents, with the requirements of the Code, with ADAAG, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as determined by the Engineer.

B. Install wall tile in accordance with ANSI A 108.5 and TCA Method W 244.

C. Install grout per ANSI A108.10.

D. Set tile in minimum notched bed of 3/32-in thickness trowel

E. Should some "flash-patching" be necessary to alleviate minor unit-to-unit variance in masonry back-up, the addition of fine-screened sand in recommended proportion will be allowed. No other modification of the Manufacturer's formulation will be permitted.

F. Walls Tile Joint Widths: 1/16-in, unless otherwise indicated.

3.07 INSTALLATION – FLOOR TILE AND MARBLE THRESHOLDS

A. Installation shall comply with the requirements of the Contract Documents, with the requirements of the Code, with ADAAG, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Install floor tile per ANSI A108.5 and TCA Method F113.

C. Install grout per ANSI A108.10.

D. Floor Tile Joint Widths: Mosaic Floor Tile: 1/8-in, unless otherwise indicated.

E. Thresholds shall be installed at locations indicated; thresholds shall be set in same type of setting bed as abutting field tile, unless otherwise indicated.

1. Thresholds shall be set in latex-Portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent non-tile floor finish.

3.08 GROUTING

A. Grout joints full to the bottom of the rounded edge of the bevel or flush at square edge tile. Grout shall be forced into joints according to Manufacturer's instructions. Joints shall be sponged and tooled. Fog grouting as required for proper curing.

B. Provide open joints for sealant where required.

3.09 CLEANING, FINISHING, AND PROTECTION

A. Cleaning:

1. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

a. Remove masking film and temporary labels as soon as possible after installation. Film and labels left in place after installation shall be the responsibility of the Contractor.

b. Latex-Portland cement grout residue shall be removed from tile as soon as possible.

c. Residue shall not be left on any surfaces

2. Upon completion of the installation, ceramic tile and appurtenances shall be cleaned of all dirt, adhesives, and other foreign matter to the satisfaction of the Engineer.

a. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

b. Cleaning shall be performed in accordance with the Manufacturer’s written instructions.

3. Before final inspection, protective coverings shall be removed and neutral cleaner shall be rinsed from tile surfaces.

B. Finishing:

1. Finished installation shall be left clean and free of cracked, chipped, broken, nonbonded, and otherwise defective tile Work.

C. Protection:

1. Ceramic tile shall be protected from damage from subsequent construction operations.

a. Protect the Work at all times and arrange for the closing off of traffic and other Work when this is necessary to avoid damage to finished surfaces.

b. When recommended by tile Manufacturer, a protective coat of neutral protective cleaner shall be applied to completed tile walls and floors. Installed tile shall be protected with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

c. Foot and wheel traffic shall be prohibited from tiled floors for at least 7 days after grouting is completed, and be allowed thereafter only after approval of Installer.

D. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

E. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

F. When ceramic tile Work is completed, remove unused materials, containers, and equipment, and clean the Site of ceramic tile debris.

END OF SECTION

SECTION 09 51 13 – ACOUSTICAL PANEL CEILINGS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Suspended acoustical tile

B. Related Requirements:

1. Divisions 15 and 16 – Mechanical and electrical ceiling penetrations.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

Acoustical Material Association (AMA)	
Specification for Acoustical Tile and Lay-in Panel Ceiling Suspension Systems	
ASTM International (ASTM)	
ASTM A 580/580M	Standard Specification for Stainless Steel Wire
ASTM A 641/A 641M	Zinc-Coated (Galvanized) Carbon Steel Wire
ASTM A 653/653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A 1008/1008M	Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
ASTM B 633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM C 423	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method
ASTM C 635	Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings
ASTM C 636	Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels

ASTM C 834	Standard Specification for Latex Sealing Compounds
ASTM D 3273	Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 580	Application of Ceiling Suspension Systems from Acoustic Tile and Lay-in Panels in Areas Requiring Seismic Restraint
ASTM E 1264	Standard Classification for Acoustical Ceiling Products
ASTM E 1414	Standard Test Method for Airborne Sound Attenuation between Rooms sharing a Common Ceiling Plenum
ASTM E 1477	Luminous Reflectance Factor of Acoustical Materials by Use of Integrating-Sphere Reflectometers
Building Code	
Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as “the Code.”	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures:

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certificates:

1. Certification of compliance with the requirements of 2.01.A.

a. Include The Code Evaluation Report for seismic performance.

2. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

3. Certificate attesting that the mineral based acoustical tile contain recycled material and showing percent of such material in accordance with the requirements indicated.

C. Shop Drawings and Calculations:

1. Complete Shop Drawings showing location and detail of installation, and design calculations.

2. Shop Drawings and Calculations shall be prepared, approved, and stamped by a professional civil engineer licensed per local engineering licensing laws.

3. Shop Drawings shall be drawn to sufficient scale and shall include pattern of acoustical tile, cut tile, suspension system, dimensions, details, connections, accessories, and trim of acoustical ceiling tile layout for all areas.

4. Shop Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories.

    a. Indicate method of anchoring and fastening.

    b. Indicate necessary connections to Work of other trades.

    c. Indicate locations of light fixtures, ceiling diffusers, grilles, sprinkler heads, smoke/fire detectors and alarms, and etc.

    d. Indicate where different tile types will be installed.

    e. Indicate splayed and counter-splayed suspension system hanger wires.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 6-in by 6-in acoustical tile sample for each type of tile proposed.

3. 8-in long suspension system sample.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Suspended acoustical tile, suspension system, and accessories shall be provided by a single Manufacturer.

B. Qualifications:

1. Manufacturers:

a. A minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

2. Installers:

a. A minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's 10 year written warranty to cover defects in materials, products, and manufacturing workmanship. The term of the warranty shall begin on the date of Substantial Completion.

a. Warranty shall contain an agreement to repair or replace suspended acoustical tile systems that fail within the warranty period. Failures include, but are not limited to, sagging and warping of panels; rusting and Manufacturers defects of grid system.

1.08 EXTRA MATERIALS

A. Provide 10 full size units, and enough field cut tile to fill one case, for each type of tile being provided for the Work for future maintenance and replacement. Provide extra materials separately packaged, identified, and left with the Owner.

B. Extra materials shall be provided from the same production run as the materials installed.

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Structural Requirements:

1. Suspended Acoustical Tile, including related assemblies, components, and attachment details, shall comply with the Code and shall be designed and installed for resistance to the structural design criteria indicated on the Drawings in accordance with the Code. Where a conflict occurs between the requirements of this Section and the Code, the more stringent shall apply.

2. Suspended acoustical tile ceiling system shall be engineered by the Manufacturer to carry the applied dead and live loads and shall have the capability to support the finished ceiling, light fixtures, air diffusers, and accessories indicated with a deflection of less than 1/360 of the span, and shall be level to within 1/8-in in 12 ft. The ceiling system shall conform to ASTM C 635 (heavy duty classification) with a minimum load carrying capacity of the main runner of 16 lb/linear foot of span of 4 ft.

3. Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials if required to conform to the structural design criteria indicated and to other performance requirements herein.

B. Design Requirements:

1. System Manufacturer shall furnish the systems herein, including necessary modifications to meet the indicated requirements and to maintain visual design concepts as approved by the Engineer.

2. Contractor shall furnish professional design and engineering services as required for metal wall, roof and soffit panels, accessories and appurtenances as indicated herein.

a. Professional design and engineering services may be provided by the Manufacturer or by an independent licensed civil engineer retained by the Contractor, either of which shall comply with the requirements indicated.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to the requirements herein, provide products from the Manufacturer listed below, or equal:

1. Armstrong World Industries, Inc.

B. Suspended Acoustical Tile – Type A:

1. Wet-formed, mineral fiber tile with DuraBrite acoustically transparent membrane, Ultima Beveled Tegular (1911).

2. 24-in by 24-in by ¾-in, beveled tegular edge tile, fine texture, non-directional.

3. Sag-resistant formulation, Armstrong HumiGuard Plus, or equal.

4. Factory applied, white acrylic latex paint finish.

5. Mold/Mildew Inhibitor: Surfaces shall be treated with a paint that contains a special biocide that inhibits or retards the growth of mildew, ASTM D 3273, Armstrong Bioblock, or equal.

6. Performance Requirements:

ASTM C 423 (UL Label)	Noise Reduction Coefficient (NRC): 0.70
ASTM C 1414 (UL Label)	Ceiling Attenuation Class (CAC): 35
ASTM E 84; ASTM E 1264 (UL Label)	Class A; Flame Spread 25 or less; Smoke Developed 50 or less, Type IV, Form 2, Pattern E
ASTM E 1477	0.90
Recycled content	60 percent to 80 percent

C. Suspended Acoustical Tile – Type B: (Not Used)

2.03 SUSPENSION SYSTEM – EXPOSED GRID

A. Description:

1. Hot dipped galvanized steel main tees, cross tees, and wall moldings, Prelude XL Exposed Tee.

a. All steel roll formed parts shall be chemically cleaned, electro-galvanized in accordance with ASTM C 635 and bonderized to resist corrosion and shall form a chemical affinity for paint.

b. Steel stamped parts shall be chemically cleaned, electro-galvanized, and treated with a chromate conversion coating.

2. Exposed surfaces shall have factory applied, low sheen, satin finish, white baked polyester paint.

3. Main beams and cross tees shall be double web steel construction with a 15/16-in flange surface with rotary stitching and peak form design.

4. All components shall conform to the intermediate structural classification of ASTM C 635 for heavy-duty systems.

5. Suspension system shall be made of 25 percent recycled content

2.04 ACCESSORIES

A. Provide accessory items as required to achieve satisfactory ceiling installation and performance.

B. Wall molding shall match the suspension system in material and finish and shall have a flange of not less than 2-in. Inside and outside corner caps shall be provided.

C. Hanger and diagonal bracing wires shall be minimum 12-gauge and shall conform to ASTM A 580/A 580M, annealed type 304 stainless steel.

1. Hangers and attachment shall support a minimum 300-pound ultimate vertical load without failure of supporting material or attachment.

D. Straps shall be 1-in by 3/16-in galvanized steel conforming to ASTM A 653/A 653M, with a light commercial zinc coating or ASTM A 1008/A 1008M with an electrodeposited zinc coating conforming to ASTM B 633, Type RS.

E. Rods shall be 3/16-in diameter threaded steel rods, zinc or cadmium coated.

F. Spacers shall be tempered spring steel and shall be fitted into wall molding to provide tension on the ceiling system.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Each carton shall carry an approved independent laboratory classification for acoustical performance (NRC, CAC, and AC).

2. Identify acoustical ceiling components with appropriate markings of applicable testing and inspection organizations for fire performance characteristics.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 APPLICATION SCHEDULE

A. Unless otherwise indicated, provide Type B tile in janitor closets, toilet, locker, and shower rooms. Provide Type A elsewhere where suspended acoustical tile is indicated.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where suspended acoustical tile will be installed for compliance with requirements for installation, taking into account tolerances, and other conditions affecting performance of installed suspended acoustical tile.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Installation of acoustical materials shall not be made when the building is excessively cold and damp, or hot and dry. Temperature and humidity conditions closely approximating the interior conditions that will exist when the building is occupied shall be maintained before, during, and after installation.

1. All windows, glazing, doors, roofing, and other waterproofing and weatherproofing cladding systems of the building shell shall be in place and complete.

C. Areas to receive suspended acoustical tile systems shall be free from construction dust and debris prior to installation.

D. Interior finish Work such as wallboard, tile, painting, and "wet-work" shall be complete and dry before installation. Mechanical, electrical, and other Work above the ceiling line shall be completed and heating, ventilating, and air conditioning systems shall be installed and operating in order to maintain temperature and humidity requirements.

E. Protect surrounding Work from damage that may result from operations under this Section.

3.05 LAYOUT

A. Unless otherwise indicated, suspended acoustical tile shall be laid out symmetrically about the center of the room to provide least number of cut tiles, and where cut tiles are required, to provide the largest size border units possible.

1. Main grid members shall be installed on 24-in centers and along each long side of rows of light fixture suspended with hangar wire at 48-in on centers, maximum.

2. Cross tees shall be spaced 24-in on center to form 24-in by 24-in module.

3. Install wall moldings with mitered corners at intersection of ceilings and at all vertical surfaces.

4. Suspended acoustical tile shall be laid in a pattern with all edges in alignment and with all faces in a plane. There shall be no noticeable variations in the finish ceiling plane.

5. Non-directional tile shall be laid so no fissure pattern direction is established.

B. Items located within the ceiling plane such as, light fixtures, air diffusers, speakers, smoke detectors, fire sprinkler heads, and other features shall be installed at the locations indicated, shall be coordinated with other trades, and shall be installed so that all installations Work together without interference.

1. Elements belonging to any other function (i.e., light fixtures) shall not be supported from the ceiling.

3.06 BEAM SPLICES AND TEE INTERSECTIONS

A. Main beams shall be joined together by a splice clip, which draws the members tightly together with bottom flanges flush. Cross tee intersections shall be joined together by interlock methods, by positioning the ends of the cross tees snugly against the main beam and in holding the cross tees in vertical alignment with bottom flanges flush. Main beam splices and cross tee intersections shall be capable of withstanding the loads required.

B. The main beams and cross tees which terminate at the walls shall be attached to a perimeter wall molding, which shall be continuous along at least 2 intersecting walls, with spring steel clips. Wall molding shall be securely attached to the walls at a minimum of 16-in intervals.

3.07 HORIZONTAL RESTRAINT

A. Suspended acoustical tile systems shall be provided with diagonal bracing wires. Horizontal restraints shall be affected by minimum 4 No. 12-gauge wires secured to the main beams within 2-in of the cross tee intersection and splayed 90 degrees from each other at an angle not exceeding 45 degrees from the plane of the ceiling. These horizontal restraint points shall be placed 12 ft on center in both directions with the first point within 4 ft from each wall. The restraint wire attachment to the supporting structure shall be adequate for the loads imposed. Cable trays and electrical conduit shall be independently supported and braced

B. Seismic Design: Horizontal restraint system includes, but is not limited to the following; suspension system shall be attached to two adjacent walls – opposite walls shall have ¾-in clearance, ends of main beams and cross tees shall be tied together to prevent their spreading, perimeter support wires shall be provided, heavy-duty suspension system is required, ceiling areas over 1,000 square feet shall have horizontal restraint wire or rigid bracing, ceiling areas over 2,000 square feet shall have seismic separation joints or full height partitions, ceilings without rigid bracing shall have 2-in oversized trim rings for sprinklers and other partitions, changes in ceiling plane shall have positive bracing, cable trays and electrical conduit shall be independently supported and braced. Changes in ceiling plane shall have positive bracing. Refer to the Code for additional requirements.

3.08 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with the requirements of the Code, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

    1. Installation will be subject to special inspection per the Code.

B. The system shall be installed so that the ceiling panels may be removed and replaced without damage, and so that main beams and cross tees can be removed or replaced without deforming the members or disturbing the balance of the grid system.

C. The suspended acoustical tile ceilings shall be erected level and in a continuous sequence.

D. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, level, and true to line, allowing for required movement, including expansion and contraction.

1. Mechanical fastenings shall not be exposed in the finished Work.

E. Suspension System:

1. Suspension system shall be installed in accordance with ASTM C 636 and as specified herein.

2. For Seismic Design Category D, E, F: Main beam and cross tee ends tied together to prevent their spreading.

3. Hangers shall be laid out for each individual room or space. Hangers shall be placed to support framing around beams, ducts, columns, grilles, and other penetrations through suspended acoustical tile system.

a. For Seismic Design Category D, E, and F provide perimeter support wires.

4. Wherever required to bypass an object with the hanger wires, a sub-suspension system shall be installed, so that all hanger wires will be plumb.

5. Main runners and carrying channels shall be kept clear of abutting walls and partitions. At least two main runners shall be provided for each ceiling span.

6. Plumb Hangars: Hangers shall be plumb and shall not press against insulation covering ducts and pipes. Where lighting fixtures are supported from the suspended ceiling system, hangers shall be provided at a minimum of four hangers per fixture and located not more than 6-in from each corner of each fixture.

7. Splayed Hangars: Where hangers must be splayed (sloped or slanted) around obstructions, the resulting horizontal force shall be offset by bracing, counter-splaying, or other acceptable means.

8. Wall Molding:

a. Wall molding shall be provided where ceilings abut vertical surfaces. Miter corners where wall moldings intersect or install corner caps. Wall molding shall be secured not more than 3-in from ends of each length and not more than 16-in on centers between end fastenings.

b. For Seismic Design Category D, E, and F, grid shall be attached to wall molding.

9. Acoustical Tile:

a. Acoustical tile shall be installed in accordance with the approved installation instructions of the Manufacturer. Edges of acoustical units shall be in close contact with metal supports, with each other, and in true alignment.

b. Acoustical tile shall be arranged so that units less than one-half width are minimized.

c. Tile in exposed-grid system shall be held in place with Manufacturer's standard hold-down clips, if units weigh less than 1 psf or required for fire resistance rating.

F. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

3.09 PROBLEM AREAS

A. Manufacturer's published recommendations and specifications shall be followed for installation, materials, and treatment of problem areas; provided, that the Manufacturer's published recommendations and specifications are not less than those required by AMA "Specification for Acoustical Tile and Lay-In Panel Ceiling Suspension Systems," and the Code.

3.10 CLEANING

A. Following installation, dirty or discolored surfaces of suspended acoustical tile, suspension system, and exposed accessories shall be cleaned and left free from defects.

B. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Film and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

C. Upon completion of the installation, suspended acoustical tile and appurtenances shall be cleaned of all dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

D. Suspended Acoustical Tile shall be protected from damage from subsequent construction operations.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer, at no additional cost to the Engineer.

G. When suspended acoustical tile Work is completed, remove unused materials, containers, and equipment, and clean the Site of suspended acoustical tile debris.

END OF SECTION

SECTION 09 65 00 – RESILIENT FLOORING

PART 1 -- GENERAL

1.01 SUMMARY

A. Section includes

1. Vinyl composition tile and resilient base

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

D. Reference Standards

Americans with Disabilities Act (ADA)	
ADAAG	Americans with Disabilities Accessibility Guidelines
ASTM International (ASTM)	
ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E 648	Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source
ASTM E 662	Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials
ASTM F 710	Standard Practice for Preparing Concrete Floor Slabs to Receive Resilient Flooring
ASTM F 970	Standard Test Method for Static Load Limit
ASTM F 1066	Vinyl Composition Floor Tile
ASTM F 1861	Standard Specification for Resilient Wall Base
ASTM F 1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Sub-floor Using Anhydrous Calcium Chloride
ASTM F 2170	Standard Test Method for Determining Relative Humidity in Concrete Slabs using In Situ Probes
Architectural Transportation Barriers Compliance Board (ATBCB)	
	Slip Resistance Advisory Guidelines
Building Code	

	Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referred to herein as “the Code”.
Green Seal Standards	
GS-36 -	Standard for Commercial Adhesives, July 12, 2013
National Fire Protection Agency (NFPA)	
NFPA 253	Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source
NFPA 258	Standard Research Test Method for Determining Smoke Generation of Solid Materials
Scientific Certification Systems (SCS) / Resilient Floor Covering Institute (RFCI)	
SCS/RFCI	FloorScore IAQ Testing and Certification Program – California Specification 01350 compliance
South Coast Air Quality Management District (SCAQMD)	
SCAQMD	Rule No. 1168

1.03 SUBMITTALS

A. Product Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

a. Tile Manufacturer’s standard color and pattern charts for color selection by the Owner.

b. Base Manufacturer’s standard color charts for color selection by the Owner.

c. Edging Manufacturer’s standard color charts for color selection by the Owner.

B. Certificates:

1. Certification by the tile and base Manufacturer that the tile and base materials provided are suitable for, and compatible with, the required installation.

2. Certification by the tile and base Manufacturer that the products supplied are compatible with the adhesives, primers, patching and leveling compounds, fillers, and surfacers required.

3. Certification from the tile Manufacturer that the polish is suitable for, and compatible with, the tile.

4. Certification that the tile has been tested by an independent laboratory and complies with ASTM E 648/NFPA 253 and ASTM E 662/NFPA 258.

5. Certification by the tile Manufacturer that provided the products conform to ASTM F 1066, Class II, Through Pattern.

6. Certification by the base Manufacturer that the products conform to ASTM F 1861, Type TP, Group 1 (solid) or Group 2 (layered).

7. Certification by the base Manufacturer that the products conform to ASTM E 84, Class C.

8. Independent certification that the products comply with the VOC limits and VOC performance criteria indicated.

9. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, Manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

10. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

11. Certification that the required substrate tests have been performed, and that the substrates are suitable for the installation.

C. Shop Drawings:

1. Complete shop drawings showing location and detail of installation.

2. Tile layout, patterns, and control joint locations and details.

3. Base details, utilizing maximum base length dimensions as possible.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. 8-in by 8-in of each vinyl composition tile type, color, and pattern to be provided.

3. 8-in long sample of each resilient base type, and color to be provided.

1.05 CLOSEOUT SUBMITTAL

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Vinyl composition tile shall be provided by a single Manufacturer.

a. Each color, grade, finish, type, composition, and variety of tile shall be obtained from a single production run.

2. Resilient base shall be provided by a single Manufacturer.

3. Adhesives, primers, patching and leveling compounds, fillers and surfacers shall be provided by a single Manufacturer, each.

4. Polish shall be provided by a single Manufacturer.

B. Qualifications:

1. Manufacturers:

a. Tile Manufacturer shall have a minimum of 15 years of vinyl composition tile manufacturing experience.

b. A minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

c. Manufacturers without these qualifications will not be accepted.

2. Installers:

a. A minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

b. Installer shall be trained, authorized, and approved by the Manufacturer to install the Manufacturer's product.

c. Installers without these qualifications will not be accepted.

C. Mock-Ups:

1. Prior to installation, erect sample mock-up of the tile using materials and details required for final Work. The panel shall be approximately 8-feet (2.3 m) by 8-feet (2.4 m). The sample mock-up shall show the workmanship, joints, colors, layout and pattern of the tile.

2. The sample panel shall be erected in a location as designated by the Engineer.

a. The sample panel may be constructed as part of the Work, but must be constructed to the satisfaction of both the Engineer and the Owner prior to acceptance of the panel, and must be accepted prior to proceeding with the remainder of the vinyl composition tile and resilient base Work.

b. If the sample mock-up is provided separate from the Work, retain mock-up during construction as a standard for judging completed Work. Do not alter, move, or destroy mock-up until Work is completed.

3. Obtain Engineer's and Owner's acceptance of qualities of mock-up before installation. Modify and/or reconstruct sample mock-up at the direction of the Engineer until acceptance.

4. Acceptance of sample mock-up shall not relieve the Contractor from compliance with the Contract Documents.

1.07 WARRANTY

A. Manufacturer Warranty

1. Furnish Manufacturer's 5 year written warranty to cover defects in materials, products, and manufacturing workmanship.

a. The term of the warranty shall begin on the date of Substantial Completion.

1.08 EXTRA MATERIALS

A. A 5 percent overage of calculated coverage for each type of tile and six 4-foot (1.2 m) lengths of resilient base being furnished for the Work shall be provided for future maintenance and replacement, separately packaged, identified, and left with the Owner.

B. Extra materials shall be provided from the same production run as the materials installed.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Design Requirements:

1. The Contractor shall coordinate color samples with other Sections through the submittal process.

2.02 VINYL COMPOSITION TILE

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide products from one of the Manufacturer's listed below, or equal

a. Armstrong; Imperial Texture, Standard Excelon.

b. Mannington; Designer Essentials.

B. Description:

1. Tile shall be a composed of polyvinyl chloride resin binder, plasticizers, fillers, and pigments with colors and texture dispersed uniformly through its thickness.

2. Tile shall have an overall thickness of 0.125-in nominal, and shall be 12-in by 12-in nominal size.

3. Coefficient of Friction (COF) ASTM C 1028 shall be greater than or equal 0.60, per ADAAG and ATBCB.

4. Tile shall be SCS/RFCI FloorScore Certified for low VOC's.

5. Performance Standards:

ASTM E 648/NFPA 253	Greater than or equal to 0.45 watts/sq cm, Passes Class I
ASTM E 662/NFPA 258	Less than 450-passes
ASTM F 970	Static Load Limit, 125 psi
ASTM F 1066	Class II, Through pattern, asbestos-free

2.03 RESILIENT BASE

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide products from one of the Manufacturer's listed below, or equal

a. Armstrong; Color-Integrated Wall Base.

b. Johnsonite; Traditional Rubber Wall Base.

c. Roppe; 700 Series Wall Base.

B. Description:

1. Base shall be Type TP thermoplastic extruded resilient, smooth and free from imperfections.

2. Unless otherwise indicated, base shall be 1/8-in thick by 4-in high, matte finish.

3. Profile: Style B (Cove), unless otherwise indicated.

4. Performance Standards:

ASTM E 84	Flame Spread 150, Class C
ASTM E 648/NFPA 253	Greater than or equal to 0.45 watts/sq cm, Passes Class I
ASTM E 662/NFPA 258	Less than 450 – passes
ASTM F 1861	Type TP, Group 1 or Group 2

5. Provide in rolls to be cut in lengths required.

6. Provide standard inside and outside preformed corners with base system.

2.04 EDGING

A. Edging shall comply with the performance standards for resilient base as indicated above.

B. Edging shall be compatible with the tile and shall be 1-in minimum width homogeneous resilient.

C. Edging shall be installed at the juncture between vinyl composition tile and carpeting and/or between vinyl composition tile and exposed concrete floors.

2.05 COLORS AND PATTERNS

A. Color of tile, base, and edging shall be selected and approved by the Owner from the Manufacturer's full color range.

1. Tentative color selection:

a. Tile – Provide for 3 different tile colors to be selected.

b. Base – To Be Selected.

c. Edging – To Be Selected.

2. The Owner reserves the option of changing this tentative color selection during the submittal process.

3. Final colors, pattern, and appearance shall be selected and approved by the Owner prior to installation.

2.06 ADHESIVES, SEALANTS, AND SEALANT PRIMERS

A. Subject to the requirements herein, adhesives, sealants, and sealant primers shall be as recommended by the tile and base Manufacturer, respectively, as applicable to the project conditions.

B. Adhesives, sealants, and sealant primers shall be low VOC per SCAQMD Rule No. 1168.

C. Adhesives, sealants, and sealant primers shall be resistant to alkalis and moisture and shall be capable of securely holding the materials in place, sealing and bonding the joints.

D. Aerosol adhesives shall comply with GS-36 VOC limits.

2.07 PATCHING AND LEVELING COMPOUNDS, FILLERS AND SURFACERS

A. Floor surface preparation materials shall be as recommended by the Manufacturer as applicable to the project conditions.

B. Floor surface preparation materials shall be low VOC per SCAQMD Rule No. 1168.

2.08 POLISH

A. Floor polish shall be suitable for, and compatible with, the tile, as recommended by the tile Manufacturer.

B. Floor polish shall be low VOC per SCAQMD Rule No. 1168.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where tile, base, and edging will be installed for compliance with requirements for installation, taking into account tolerances, and other conditions affecting performance of installed tile, base, and edging.

a. Substrates for setting tile and base shall be firm, sound, dimensionally stable, dry, clean, free from oil, waxy films, curing compounds, and other foreign substances; and shall be within flatness tolerances required by the Manufacturer, or by the referenced standards, whichever is more stringent shall apply.

b. Perform calcium chloride test in accordance with ASTM F 1869. The maximum acceptable moisture vapor emission shall not exceed 3 pounds per 1,000 square feet (305 square meters) per 24 hours. Follow adhesive Manufacturer's instructions to achieve acceptable moisture vapor emission levels for proper installation.

c. Perform substrate humidity test in accordance with ASTM F 2170. Comply with tile Manufacturer's written instructions to achieve acceptable relative humidity levels in the concrete slab prior to applying flooring materials. In no case should the humidity levels in the slab be greater than 75 percent prior to applying materials.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after application.

B. Installation shall not be made when the building is excessively cold and damp, or hot and dry. Temperature and humidity conditions closely approximating the interior conditions that will exist when the building is occupied shall be maintained before, during, and after installation.

1. All windows, glazing, doors, roofing, and other waterproofing and weatherproofing cladding systems of the building shell shall be in place and complete.

C. Do not apply flooring materials until the Work of other trades, including painting, has been completed.

1. Exceptions include furniture, equipment, and moveable partitions.

D. Allow tile and base to reach room temperature or minimum temperature recommended by Manufacturer before beginning installation.

E. Protect adhesives from freezing. Follow Manufacturer's recommendations for minimum temperatures to which adhesives are exposed.

F. Protect surrounding Work from damage that may result from operations under this Section.

3.04 SURFACE PREPARATION

A. Surface preparation shall be in compliance with ASTM F 710, and with the Manufacturer's written instructions.

B. Coatings, including curing compounds, and other substances that contain soap, wax, oil, or silicone, that are incompatible with flooring materials shall be removed by using a terrazzo or concrete grinder, a drum sander, or a polishing machine equipped with a heavy-duty wire brush.

C. Protrusions, bumps, ridges, and loose substrate surface materials shall be removed by sanding or grinding.

D. Trowelable leveling and patching compounds shall be used per tile Manufacturer's written instructions to fill cracks, holes, and depressions.

E. Immediately before application of tile and base materials, scrape surfaces to be covered free from foreign materials and brush clean.

F. Substrate shall be swept to remove all loose materials prior to beginning tile and base installation.

3.05 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with the requirements of the Code, with ADAAG, with applicable references, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply as directed by the Engineer.

B. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

C. Vinyl Composition Tile Installation:

1. Match tiles for color and pattern by using tile from cartons in same sequence as manufactured and packaged if so numbered. Broken, cracked, chipped, or deformed tiles will not be accepted.

2. Lay tile from center marks established with principal walls, discounting minor offsets, so that tile at opposite edges of room is of equal width. Adjust as necessary to avoid use of cut widths less than 1/2 tile adjacent to room perimeters as applicable. Lay tile in grid pattern square to room axis. Fit tile tightly to walls and doorframes getting edge of tile to back of racked joint in masonry walls.

3. Install tile wall-to-wall before the installation of furniture, equipment, and moveable partitions.

4. Extend tile into toe spaces, door recesses, closets, and similar openings as indicated or as required.

5. Scribe, cut, and fit tile neatly around permanent fixtures, including but not limited to, columns, walls, partitions, pipes, outlets, built-in furniture and casework.

D. Resilient Base Installation:

1. Apply adhesive in a thin but thorough covering coat in accordance with the Manufacturer's instructions.

2. Cut materials to proper size and press firmly into adhesive over full contact area. Fit closely at joints and abutting surfaces. At doors, stop base at outside edge of reveal in doorframe and cut at 45 degrees to corner of masonry adjoining frame.

3. Base shall be applied in long lengths with joints at corners only and upon completion the bottom edge shall be in firm contact with the finished floor.

4. For sealing joints between top of the wall base and irregular wall surfaces, such as masonry or similar, provide plastic filler applied according to the Manufacturer's written instructions.

E. Upon completion, tile, base, and appurtenances shall form a smooth, firm flat plane free from waves, buckles, cracks, breaks, bumps, and projecting edges.

3.06 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Film and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces

B. Upon completion of the installation, tile, base and appurtenances shall be cleaned of dirt, adhesives, and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Apply polish in accordance with Manufacturer's written instructions.

D. Tile and base shall be protected from damage from subsequent construction operations.

1. Protect the Work at all times and arrange for the closing off of traffic and other Work when this is necessary to avoid damage to finished surfaces.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced as determined by Engineer.

G. When tile and base Work is completed, remove unused materials, containers, and equipment, and clean the Site of tile and base debris.

END OF SECTION

SECTION 09 96 00.10– HIGH-PERFORMANCE COATINGS

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide protective coatings, complete and in place, in accordance with the Contract Documents.

B. Definitions

1. The term "paint," "coatings," or "finishes" as used herein, shall include surface treatments, emulsions, enamels, paints, epoxy resins, and other protective coatings, excepting galvanizing or anodizing, whether used as a pretreatment, primer, intermediate coat, or finish coat.

2. The term "DFT" means Dry Film Thickness.

C. The following surfaces shall not be coated:

1. Concrete, unless required by items on the concrete coating schedule below or the Drawings.

2. Stainless steel

3. Machined surfaces

4. Grease fittings

5. Glass

6. Equipment nameplates

7. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

8. Platform gratings, stair treads, door thresholds, and other walk surfaces, unless specifically indicated to be coated.

D. The coating system schedules summarize the surfaces to be coated, the required surface preparation, and the coating systems to be applied. Coating notes on the Drawings are used to show or extend the limits of coating schedules, to show exceptions to the schedules, or to clarify or show details for application of the coating systems.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 60 00	Products, Materials, Equipment, and Substitutions

C. Reference Standards

ASTM International (ASTM)	
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM D3276	Standard Guide for Painting Inspectors (Metal Substrates)
ASTM D4060	Abrasion Resistance of Organic Coatings by the Taber Abraser
ASTM D4262	Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces
ASTM D4263	Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4417	Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
ASTM D6386	Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting
ASTM F1869	Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
American Water Works Association (AWWA)	
AWWA D102	Coating Steel Water-Storage Tanks
ANSI/AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
NACE International (NACE)	
NACE RP0287-02	Field Measurement of Surface Profile of Abrasive Blast-Cleaned Steel Surfaces Using a Replica Tape
Occupational Safety and Health Administration (OSHA)	
OSHA 29CFR1910.1200	Hazard Communication
Society for Protective Coatings (SSPC)	
SSPC Guide 12	Guide for Illumination of Industrial Painting Projects
SSPC PA 1	Shop, Field, and Maintenance Coating of Metals
SSPC PA Guide 11	Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating
SSPC SP 1	Solvent Cleaning
SSPC SP 2	Hand Tool Cleaning
SSPC SP 3	Power Tool Cleaning
SSPC SP 5/NACE No. 1	White Metal Blast Cleaning
SSPC SP 6/NACE 3	Commercial Blast Cleaning

SSPC SP 7/NACE 4	Brush-off Blast Cleaning (NACE No. 4)
SSPC SP 10/NACE 2	Near-White Blast Cleaning
SSPC SP 11	Power Tool Cleaning to Bare Metal
SSP SP 13	Surface Preparation of Concrete

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Submittals shall include the following information and be submitted at least 30 Days prior to commencing protective coating Work:

1. Materials List: A copy of a coating materials list showing the manufacturer and the product number, keyed to the coating systems herein. The list shall be submitted prior to or at the time of submitting samples.

2. Manufacturer's Information: For each coating system to be used, the following data:

a. Manufacturer's data sheet for each proposed product

b. Manufacturer’s statements on the suitability of the proposed products for the intended use. Include in the statement confirmation that the coating manufacturer’s technical engineering representative inspected all existing substrate and/or surfaces with existing coatings and confirmed that the proposed products, application procedures and surface preparation requirements are compatible with the coatings required by this Section.

c. Technical and performance information that demonstrates compliance with the system performance and material requirements.

d. Paint manufacturer's instructions and recommendations on surface preparation and application.

e. Colors available for each product (where applicable).

f. Compatibility of shop and field applied coatings (where applicable).

g. Safety Data Sheet for each product proposed.

C. Samples

1. Samples of paint, finishes, and other coating materials shall be submitted on 8-1/2 inch by 11-inch sheet metal. Each sheet shall be completely coated over its entire surface with one protective coating material, type, and color.

2. Two sets of color samples to match each color selected by the Owner from the manufacturer's standard color sheets. If custom mixed colors are indicated, the color samples shall be made using color formulations prepared to match the color samples furnished by the Owner Engineer .

3. One 5 pound sample of each abrasive proposed to be used for surface preparation for submerged and severe service coating systems.

D. Experience Requirements of the Field Applicator:

1. Submit a project organization chart showing the full name and clear lines of responsibility and duties for all personnel scheduled to perform work (including office managers, quality control supervisor and safety supervisor) on the project.

2. Submit for documentation a statement on company letter head indicating the name of the Quality Control Supervisor (QCS) who has been given written authority by executive management to perform the duties of the QCS position for the project. Include in the statement the date of last successful completion of training to perform the QCS position. Acceptable coating inspection training programs include at a minimum: SSPC (PCI, NBPI, BCI) Level 1, KTA Level 1, GPI (Level 1), NACE (CIP Level 1, Frosio) or equivalent formal in-house inspection training conforming to ASTM D3276.

3. Submit for documentation the set of procedures that have been implemented for conducting and documenting training (as needed) and for qualifying trainees, newly hired craft workers and newly hired experienced workers. Include documentation of annual proficiency evaluation system for all craft workers.

4. Submit for documentation up-to-date experience, training certificates, and licenses for all personnel scheduled to perform work on the project.

5. Submit for documentation a statement on company letter head that key personnel (including but not limited to, project management and QCS) have reviewed the project contract documents and specifications in effect at contract award. Include in the statement confirmation that the project contract documents, and specifications have been distributed to all affected personnel within the organization scheduled to perform work on the project. Include in the statement the procedure for recording receipt and distribution of specifications and contract documents and all changes and revisions to contract documents. Include in the statement the procedures for documenting verbal responses from the Owner for requests for clarification.

6. Submit references of successfully completed projects for industrial coating projects completed within the last 18 calendar months. Acceptable references shall include contact information for owner staff having direct connection with the project, copies of facility owner project performance evaluations, letters of commendation from the owner or prime contractor, statements of final payment, and punch list acceptance.

E. Quality Assurance Plan

1. Submit for review the written project-specific Quality Control Program to be followed. Primary duties and responsibilities of the QCS as outlined in the Quality Control Program shall include but are not limited to the following:

a. Ensuring that qualified personnel perform the Work on the project.

b. Ensure that proper inspection forms and recording procedures are used for job quality monitoring (including those required herein).

c. Ensure correct and properly operating and calibrated equipment is used.

d. Review and sign off on Daily Inspection Reports (DIRs) on a timely basis (QCS must sign off or authorize review of DIRs by other competent QC personnel).

e. Ensure that Work is inspected for conformance with the contract requirements, good painting practice, and internal Quality Control (QC) procedures.

f. Ensure that nonconforming work and rework is properly documented.

g. Develop and/or review Inspection and Test Plans.

h. Conduct and/or review internal audits.

2. Submit for documentation written project-specific procedures for all production processes to be used on the project. The procedures shall include, but are not limited to the following:

a. Standard company or contract specific procedures are available to and used by on-site personnel for verifying that coating and related operations are performed in accordance with contract requirements and industry best practices.

b. Inspection procedures or project specific inspection plans ensuring that all work is properly performed and documented daily during coating operations or documented in accordance with contract requirements, are available to site personnel, and are used to perform in-process inspections of work at key hold points.

c. Abrasive blasting (dry or wet) and related processes

d. Water jetting and related processes

e. Hand and power tool cleaning and related processes

f. Coating mixing and related processes

g. Coating application (e.g., brush, roller, spray, mitt) and related processes

h. Top coating procedures (e.g., conditions when meeting and exceeding recoat windows)

i. Curing process for materials applied

j. Erecting, moving, and tearing down containment

k. Field audits performed on site confirming equipment is in good operating condition

3. Submit for review and documentation Daily Inspection Reports (DIRs) to Engineer on a weekly basis. All DIRs and testing results shall be maintained on file for the duration of the project. DIRs must be signed and dated by the Contractor and formally reviewed by the QCS. DIRs and other daily reports shall record project relevant observations including:

    a. Compressed air cleanliness

    b. Air temperature (dry and wet bulb)

    c. Relative humidity

    d. Dew point

    e. Substrate surface temperature

    f. Abrasive cleanliness

    g. Surface preparation cleanliness specified and achieved

    h. Surface profile specified and achieved

    i. Illumination of work area (foot candles for surface preparation, coating application, and inspection) in accordance with SSPC Guide 12 recommendations or contract requirements.

    j. Batch numbers of coatings and thinners

    k. Mixing of coatings (in accordance with coating manufacturer's mixing instructions)

    l. DFT readings for each applied coating meeting specification requirements.

    m. Inspection instruments used (manufacturer, model, and serial number)

    n. Storage temperature and storage conditions to include min/max daily, or as required.

1.04 SPECIAL CORRECTION OF DEFECTS REQUIREMENTS

A. Nonconforming work, identified by Contractor QC personnel, Owner, Engineer, or Owner's Representative performing QA on behalf of the Owner shall be documented and repaired.

B. Inspection: An inspection may be conducted during the eleventh month following completion of coating Work. The Contractor and a representative of the coating material manufacturer shall attend this inspection. Defective Work shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Owner may, by written notice to the Contractor, reschedule the inspection to another date within the one-year correction period or may cancel the inspection altogether. The Contractor is not relieved of its responsibilities to correct defects, whether or not the inspection is conducted.

C. Extended Maintenance of Chemical Tank Lining Systems: The Contractor shall promptly repair any defects in the chemical resistant sheet lining system for a period of 2 years after the lining has been placed into service. Such maintenance shall include repair of the chemical tank and any equipment or facilities damaged by the corrosive action of the chemicals.

D. Steel Reservoir Coating System Inspection**:** The Contractor shall conduct an inspection during the eleventh month after the date when the reservoir was filled with water and placed into service. The Contractor shall require a representative of the coating material manufacturer to attend the inspection. Defects shall be repaired in accordance with these specifications and to the satisfaction of the Owner. The Contractor is not relieved of its responsibilities to correct defects, whether or not the inspection is conducted. If the Contractor fails to conduct an 11-month inspection for reasons not attributed to the Owner, the Contractor is not relieved of its responsibilities to correct defects, and the correction period shall be extended until the 11-month inspection is conducted and Defective Work is repaired.

1.05 COMPLIANCE WITH VOLATILE ORGANIC COMPOUND (VOC) LIMITS

A. All paint and coating products shall comply with the applicable limits on volatile organic compounds (VOCs) as established by the United States Environmental Protection Agency and by state and local air quality regulating agencies. It shall be the Contractor's responsibility to verify compliance of all paints and coatings.

B. Listed products in this specification are based on a maximum VOC level of 100 g/L. If local limits on VOCs are higher or lower, the Contractor shall propose substitute products that are compliant with local limits and equivalent in performance to the listed product. The Engineer shall determine if the proposed product is equivalent or equal to the named product in accordance with the requirements of Section 01 60 00 - Product, Materials, and Equipment Substitutions.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Suitability: The Contractor shall use suitable coating materials as recommended by the manufacturer.

B. Material Sources: Where manufacturers and product numbers are listed, it is to show the type and quality of coatings that are required. If a named product does not comply with VOC limits in effect at the time of Bid opening, that product will not be accepted, and the Contractor shall propose a substitution product of equal quality that does comply. Proposed substitute materials will be considered as indicated below. Coating materials shall be materials that have a record of satisfactory performance in industrial plants, manufacturing facilities, and water and wastewater treatment plants.

C. Compatibility: In any coating system only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats. If necessary, a barrier coat shall be applied between existing prime coat and subsequent field coats to ensure compatibility.

D. Containers: Coating materials shall be sealed in containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, and name of manufacturer, all of which shall be plainly legible at the time of use.

E. Colors: Colors and shades of colors of coatings shall be as indicated or selected by the Engineer. Each coat shall be of a slightly different shade to facilitate inspection of surface coverage of each coat. Finish colors shall be as selected from the manufacturer's standard color samples by the Engineer. Finish colors shall be custom mixed to match color samples furnished by the Engineer.

F. Substitute or "Or-Equal" Products

1. To establish equality under Section 01 60 00 - Products, Materials, Equipment and Substitutions, the Contractor shall furnish satisfactory documentation from the manufacturer of the proposed substitute or "or-equal" product that the material meets the indicated requirements and is equivalent or better in the following properties:

   a. Suitability for the intended service

   b. Compatibility with other coatings

   c. Resistance to chemical attack

   d. Minimum and maximum recoat times

   e. Minimum and maximum cure time for immersion

   f. Abrasion resistance per ASTM D4060 using CS17 Wheel

   g. Maximum and minimum dry film thickness per coat

   h. Temperature limitations during application and in service

2. Protective coating materials shall be standard products produced by recognized manufacturers who are regularly engaged in production of such materials for essentially identical service conditions. When requested, the Contractor shall provide the Engineer with the names of not less than 10 successful applications and case histories of the proposed manufacturer's products that comply with these requirements.

3. If a proposed substitution requires changes in the Work, the Contractor shall bear such costs involved as part of the Work.

2.02 INDUSTRIAL COATING SYSTEMS

A. System 1 - Acrylic Polymer

1. Materials

Primer	Manufacturer's recommendation

Finish Coat	1 component water-based acrylic
Type	Pure acrylic emulsion
Demonstrated suitable for	ferrous and nonferrous surfaces in industrial exposure, producing high gloss surface that is resistant to mild corrosion and chemical fumes, has good color and gloss retention, good weathering, and sunlight resistance
VOC Content, max (g/L)	100

2. Application and manufacturers

Prime Coat (DFT = 2 to 4 mils)	**Finish Coat (DFT = 2 to 4 mils)**	**Total System DFT**
PPG Pitt Tech Plus	PPG Pitt Tech Plus	4 to 8 mils
Tnemec Series V115 Unibond	Tnemec Series 1028 Enduratone for Gloss finish (use Series 1029 for Semi-Gloss finish)	
Carboline Sanitile 120	Carboline Carbocrylic 3359 DTMC	
Sherwin Williams Pro Industrial Procryl	Sherwin Williams Pro Industrial Acrylic	

B. System 2 - Organic Zinc/Epoxy/Polysiloxane – Not Used

C. System 3 - Aluminum Silicone – Not Used

D. System 4 - Epoxy/Polyurethane

1. Materials

Primer type	2 component epoxy
VOC Content, max (g/L)	100
Finish type	2 component aliphatic polyurethane
VOC Content, max (g/L)	100
Demonstrated suitable for	ferrous surfaces, superior color and gloss retention, exceptional resistance to weathering, chemical fumes, and splash

2. Application and manufacturers

Prime Coat (DFT = 3 - 5 mils)	**Finish Coat (DFT = 3 - 4 mils)**	**Total System DFT**
Carboline Carboguard 890 VOC	Carboline Carbothane 134 VOC	6 - 9 mils
Tnemec Hi-Build Epoxoline II Series L69	Tnemec Endura-Shield Series 1094 for Gloss finish (use Series 1095 for Semi-Gloss finish)	
PPG Amerlock 2/400 (VOC)	PPG Amershield VOC	

Sherwin Williams Macropoxy 646-100	S W WB Acrolon 100	

E. System 5 - Inorganic Zinc/Epoxy/Polyurethane – Not Used

F. System 6 - Inorganic Zinc, Water Based – Not Used

G. System 7 - Epoxy, High Heat Under Thermal Insulation Wrap – Not Used

H. System 8 - Epoxy, Equipment

1. Materials

Primer Type	2 component epoxy
Demonstrated suitable for	Rust inhibitive, outstanding chemical, abrasion, and weathering resistance, resistance to splash, washdown, and condensation. Immersion capability is not required
VOC content, max (g/L)	100
Finish Type	2 component epoxy, available in many colors
Demonstrated suitable for	Outstanding chemical, abrasion, and weathering resistance, resistance to splash, washdown, and condensation. Immersion capability is not required
VOC content, max (g/L)	100

2. Application and manufacturers

Prime Coat (DFT = 4 - 5 mils)	**Finish Coat (DFT = 4 - 5 mils)**	**Total System DFT**
PPG- Amerlock 2/400 VOC	PPG Amerlock 2/400 VOC	8-10 mils
Tnemec Series L69	Tnemec Series L69	
Carboline Carboguard 890 VOC	Carboline Carboguard 890 VOC	
Sherwin Williams Macropoxy 646-100	Sherwin Williams Macropoxy 646-100	

I. System 9 - Inorganic Zinc/Epoxy, Equipment – Not Used

J. System 10 - Acrylic, Concrete – Not Used

K. System 11 - Not Used

L. System 12 - Polyurethane, Fiber Glass – Not Used

2.03 SUBMERGED AND SEVERE SERVICE COATING SYSTEMS

A. System 100 - Amine Cured Epoxy

1. Material

Type	high build, amine cured epoxy
VOC content, max (g/L)	100
Demonstrated suitable for	steel, long-term immersion in water and wastewater, resistant to corrosion, chemical fumes, good color retention

2. Application and manufacturers

Products (3 coats or more)	**Total System DFT**
PPG Novaguard 840	15 to 17 mils For non-submerged valves and other equipment, DFT = 10 to 12 mils
Carboline Carboguard 891 VOC	
Hi-Build Epoxoline II Series L69 for wastewater	
Sherwin Williams Tank Clad HS	

B. System 101 - (Not used)

C. System 102 - Polyamide Epoxy

1. Materials

Type	high build polyamide cure epoxy
VOC content, max (g/L)	100
Demonstrated suitable for	long term immersion in water resistant to corrosion and chemical fumes, good color retention
Certification	NSF 61 if in contact with potable water

2. Application and manufacturers

Products (3 coats or more)	**Total System DFT**
Tnemec Series 22 Epoxoline	12-18 mils
PPG- Amerlock 2/400 VOC	
Carboline - Carboguard 891 VOC	
Sherwin Williams Macropoxy 646 PW	

D. System 103 - Not Used

E. System 104 - Not Used

F. System 105 - Epoxy, Steel Reservoirs, System ICS-3

1. Materials: In accordance with AWWA D102 - Coating Steel-Water Storage Tanks, System ICS-3

2. Roof Knuckle and Structural Steel.

Type	Organic Zinc/High Solids Epoxy
Demonstrated suitable for	Headspace above high-water level
VOC content, g/L max	100
Certification required	NSF 61/600

3. Application and manufacturers

First Coat (3 - 5 mils)	**Finish Coat (17 - 34 mils)**	**Total System Min. DFT**
	PPG Novaguard 840	20 mils
Sherwin-Williams Corothane Galvpac 2K 100MCU Zinc	Sherwin Williams Sherplate PW Epoxy	
Carboline-Carboguard 891 VOC	Carboine-Carboguard 891 VOC	
Tnemec Hydro-Zinc Series 94 H2O	Tnemec Series 22 Epoxoline	

4. Shell, Floor and Support Columns.

Type	Epoxy/High Solids Epoxy
Demonstrated suitable for	Immersion service in water
VOC content, g/L max	100
Certification required	NSF 61

5. Application and manufacturers

First Coat (1.5 - 2 mils)	Finish Coat (24 - 34 mils)	Total System Min. DFT
	PPG Novaguard 840	24 mils
Sherwin-Williams Macropoxy 5500LT	Sherwin Williams Sherplate PW Epoxy	
Carboline- Phenoline Tank Shield FP	Carboline- Phenoline Tank Shield	
Tnemec Hydro-Zinc Series 94 H2O	Tnemec Series 22 20-30 mils in one or more coats	

6. All lap roof plate edges, both sides, shall be pre-coated. If necessary, primer exposed on exterior of roof may be removed prior to welding. Pre-coating shall extend at least 6-inches from plate edges.

7. Touch-up coating shall be done for areas damaged during erection, or areas not pre-coated. The Contractor shall spot sandblast to SSPC SP-5 - White Metal Blast Cleaning, before application of coating. Material used for touch-up shall be the indicated material or a compatible primer recommended by the manufacturer.

8. All edges, nuts, bolts, lap joints, weld seams, and the roof rim angle shall receive one brush-applied coat prior to the application of the first complete spray coat.

9. Curing Period: Prior to immersion, the completed system shall be subjected to at least 240 hours of curing time with the metal temperature at a minimum of 70 degrees F, or 480 hours at a minimum of 60 degrees F, both conditions at a maximum relative humidity of 50 percent and under the forced ventilation conditions required by the paragraph entitled Curing of Coatings. More curing time or a higher temperature shall be provided if recommended by the epoxy coating manufacturer. If the environmental conditions do not provide the necessary minimum temperature, use heated air to provide the necessary heat for curing. Other combinations of curing time and temperature may be used if the coating manufacturer presents satisfactory documentation and test results to substantiate that the degree of curing is equal or greater than curing for 240 hours at 70 degrees F.

10. Volatile Organic Compound Testing: The completed interior reservoir coating system shall be tested for volatile organic compounds as indicated below.

G. System 106 - Fusion Bonded Epoxy

1. Material

Type	100 percent solids fusion bond epoxy
Demonstrated suitable for	fluidized bed or electrostatic spray application, recommended for pumps, valves, pipe appurtenances, tanks, pipe hangers, flow meters, and hydrants
Certification requirement	NSF 61

2. Application in accordance with AWWA C213 and the following:

Surface Preparation	**Product**	**Surface and DFT**
SSPC SP 10/NACE 2	**3M Scotchkote 134** or **206N**	Valves 12-mils
		All others 16-mils

H. System 107 - Chemical Resistant Sheet Lining

1. Materials: The Contractor shall use natural rubber, chlorobutyl rubber, ethylene propylene diene monomer (EPDM) rubber, chloroprene polymer (neoprene) rubber, or chlorosulfonated polyethylene (Hypalon) rubber sheet lining materials as indicated. The Shop Drawing submittal shall contain technical information that confirms the suitability of the lining material system for long-term immersion in each chemical to be stored. The service temperatures are expected to be up to 150 degrees F.

2. Neoprene sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16 - inch. The lining material shall be **Polymeric Protective Linings BFG 2011 (59688),** or equal.

3. Chlorobutyl sheet lining material shall be synthetic rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be **Polymeric BFG 1051 (60924),** or equal.

4. Natural rubber (soft) sheet lining material shall be soft natural rubber formulated for steam curing at atmospheric pressure. The minimum lining thickness shall be 3/16-inch. The lining material shall be **Polymeric BFG 2004 (83160),** or equal.

5. Natural rubber (hard) sheet lining material shall be a hard, natural rubber resistant to oxidizing agents and formulated for autoclave curing. The minimum lining thickness shall be 3/16-inch. The lining material shall be **Polymeric BFG 1006 (8631),** or equal.

6. EPDM sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution and formulated for autoclave or steam curing under pressure. The lining material shall be **Polymeric BFG 1039 (EP156),** or equal.

7. Hypalon sheet lining material shall be synthetic rubber suitable for use as a lining for 50 percent sulfuric acid solution. The lining material shall be **Polymeric BFG 2045 (8706),** or equal.

8. Primers, adhesives, activators, accelerators and other necessary materials shall be as required by the sheet material manufacturer.

9. Metal Surface Preparation: Prior to abrasive blast cleaning the base metal shall be prepared as required by the sheet lining material manufacturer's installation instructions. If the instructions differ from these specifications, the highest degree of cleaning and surface preparation shall be provided. Abrasive blast cleaning shall be done in accordance with this Section.

10. Installation of lining materials shall be in accordance with the material manufacturer's written installation instructions. All interior surfaces shall be lined, including all piping, vents, fittings, flange faces, manhole covers, and blind flanges.

11. The lining system shall be holiday tested in accordance with this Section before and after curing.

12. The lining system shall be cured by steam using the time and temperature as required by the material manufacturer.

I. System 108 - Polyurethane, Concrete

1. Materials

Filler-sealer type	epoxy material with portland cement and aggregate
Primer type	Phenolicamine or polyamidoamine epoxy
VOC content, max (g/L)	100
Finish type	aromatic elastomeric polyurethane
Demonstrated suitable for	concrete and concrete block masonry, long term immersion in water and wastewater and service where subject to splash and spill of water and wastewater treatment chemicals
VOC content, max (g/L)	100
Certification requirement, where coating will be in contact with potable water	NSF 61/600

2. Application and manufacturers

Filler-Sealer	**Primer** **DFT = 3 - 7-mils**	**Finish Coat** **DFT = 100 - 125–mils, 75 mils for potable water**
Carboline – Carbocrete 4010	Carboline -Carboguard 1340 WB (optional)	Carboline -Reactamine 760
Tnemec MortarClad 218	Tnemec Pota-Pox L140 (potable water) Epoxoprime 201 (wastewater)	Elasto-Shield 406 (max 75 mils for potable water)
PPG-Amercoat 100A	PPG Raven 175	PPG Aquataflex 505
Sherwin Williams Steel Seam FT 910	Sherwin Williams Macropoxy 5000	Sherwin Williams Polycote 115

J. System 109 - Epoxy, Concrete, Manhole Liner – Not Used

2.04 SPECIAL COATING SYSTEMS

A. **System 200 - PVC Tape:** Prior to wrapping the pipe with PVC tape, the pipe and fittings first shall be primed using a primer recommended by the PVC tape manufacturer. After being primed, the pipe shall be wrapped with a 20-mil adhesive PVC tape, half-lapped, to a total thickness of 40 mils.

B. **System 201 - Rich Portland Cement Mortar:** Rich Portland cement mortar coating shall have a minimum thickness of 1/8-inch, followed by enclosure in an 8-mil thick polyethylene sheet with all joints and edges lapped and sealed with tape.

C. System 202 - (Not used)

D. System 203 - Epoxy Surfacing on Concrete Floors – Not Used

E. System 204 - Water Retardant, Concrete – Not Used

F. **System 205 - Polyethylene Encasement:** Application of polyethylene encasement shall be in accordance with ANSI/AWWA C105 using Method C.

G. **System 206 - Cement Mortar Coating:** A 1-1/2-inch minimum thickness mortar coating reinforced with 3/4-inch galvanized welded wire fabric shall be provided. The cement mortar shall contain no less than one part Type V cement to 3 parts sand. The cement mortar shall be cured by a curing compound meeting the requirements of "Liquid Membrane Forming Compounds for Curing Concrete," ASTM C 309, Type II, white pigmented, or by enclosure in an 8-mil thick polyethylene sheet with all edges and joints lapped by at least 6-inches.

H. System 207 - Not Used

I. System 208 - Aluminum Metal Isolation – Not Used

J. System 209 - Not Used

K. System 210 - Acrylic, Wood and Gypsum Board

1. Materials

Primer type	as recommended by manufacturer
Finish type	single component, water based, acrylic, fungicide added
VOC content, max (g/L)	100
Demonstrated suitable for	wood, mild to moderate exposure inside and outside building, and gypsum board, inside

2. Application and manufacturers

Prime Coat (1.5 to 2.5 mils)	**Finish Coat (4 to 6 mils) (2 coats)**	**Total System DFT**
PPG- Gripper	PPG Pitt-Tech Plus Series	5.5 to 8.5 mils
Carboline - Sanitile 120	Carboline - Carbocrylic 3359 DTMC	
Tnemec Series V115 Unibond	Tnemec Series 1028 Enduratone	

Sherwin Williams PrepRite ProBlock	Sherwin Williams Pro Industrial Acrylic	

L. System 211 – Novolac Epoxy, Concrete, Aggregate Filled, Secondary Containment, foot traffic

1. Topcoat Material

Type	Novolac epoxy, 60 – 75 mil resin system
Demonstrated suitable for	Chemical storage or feed pump areas subject to foot traffic. See Coating System Schedule, Concrete Surfaces of Chemical Secondary Containment in Part 3 for specific chemical applications

2. Application and MANUFACTURERS

a. TNEMEC

1) Surface Filler: Series 215, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations.

3) Primer: Series 201 Epoxyprime, 5-6 mils DFT

4) Base Coat: Series 239C, 25-30 mils DFT

5) Aggregate Fill, 20/40 mesh silica or garnet aggregate

6) Top Coat: Series 282 15-20 mils DFT

b. CARBOLINE

1) Surface Filler: Semstone 110 blended with fine silica and thixotrope Part D, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations, see paragraph 3.10.

3) Primer: Semstone 110, 5-6 mils DFT or Dudick Primer 67, 3-4 mils DFT

4) Base Coat: Semstone 145, 25-30 mils DFT or Dudick Protecto-Coat 100XT, 15-20 mils DFT

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat: Semstone 145, 15-20 mils DFT or Dudick Pretecto-Coat 100XT, 15-20 mils DFT

c. SHERWIN WILLIAMS

1) Surface Filler: Epoxy Mortar, Duraplate 2300, thickness as required to fill bug holes and other imperfections to produce a smooth surface.

2) Treat all cracks, construction joints, expansion joints and wall slab intersections in accordance with the coating manufacturer's recommendations, see paragraph 3.10.

3) Prime: Corobond 100 Epoxy Primer, B58 Series, 5-6 mils DFT

4) Base Coat: Cor Cote E.N. 7000, 25-30 mils DFT

5) Aggregate Fill 20/40 mesh silica or garnet aggregate

6) Top Coat : Cor Cote E.N. 7000, 15-20 mils DFT

d. PPG

1) Prime: Milamar ICO LV

2) Base Coat: Milamar ICO Hi Guard Coating

3) Top Coat: Milamar ICO Hi Guard Coating

PART 3 -- EXECUTION

3.01 MANUFACTURER'S SERVICES

A. The Contractor shall require the protective coating manufacturer to furnish a qualified technical representative to visit the Site for technical support as may be necessary to resolve field problems.

B. For submerged and severe service coating systems, the Contractor shall require the paint manufacturer to furnish the following services:

1. The manufacturer's representative shall provide at least 6 hours of on-Site instruction in the proper surface preparation, use, mixing, application, and curing of the coating systems.

2. The manufacturer's representative shall observe the start of surface preparation, mixing, and application of the coating materials for each coating system.

3.02 WORKMANSHIP

A. Skilled craftsmen and experienced supervision shall be used on coating Work.

B. Coating shall be done in a workmanlike manner so as to produce an even film of uniform thickness. Edges, corners, crevices, and joints shall receive special attention to insure thorough surface preparation. The finished surfaces shall be free from runs, drops, ridges, waves, laps, brush marks, and variations in color, texture, and finish. The hiding shall be so complete that the addition of another coat would not increase the hiding. Special attention shall be given so that edges, corners, crevices, welds, and similar areas receive a film thickness equivalent to adjacent areas, and installations shall be protected by the use of drop cloths or other precautionary measures.

C. Damage to other surfaces resulting from the Work shall be cleaned, repaired, and refinished to original condition.

3.03 STORAGE, MIXING, AND THINNING OF MATERIALS

A. Manufacturer's Recommendations**:** Unless otherwise indicated, the coating manufacturer's printed recommendations and instructions for thinning, mixing, handling, applying, and protecting its coating materials, for preparation of surfaces for coating, and for other procedures relative to coating shall be strictly observed.

B. Coating materials shall be used within the manufacturer's recommended shelf life.

C. Storage and Mixing: Coating materials shall be stored under the conditions recommended by the Product Data Sheets, and shall be thoroughly stirred, strained, and kept at a uniform consistency during application. Coatings from different manufacturers shall not be mixed together.

3.04 PREPARATION FOR COATING

A. General: Surfaces to receive protective coatings shall be prepared as indicated prior to application of coatings. The Contractor shall examine surfaces to be coated and shall correct surface defects before application of any coating material. Marred or abraded spots on shop-primed and on factory-finished surfaces shall receive touch-up restoration prior to any field coating application. Surfaces to be coated shall be dry and free of visible dust.

B. Protection of Surfaces Not to be Coated: Surfaces that are not to receive protective coatings shall be protected during surface preparation, cleaning, and coating operations.

C. Hardware, lighting fixtures, switch plates, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not to be painted shall be removed, masked, or otherwise protected. Drop cloths shall be provided to prevent coating materials from falling on or marring adjacent surfaces. The working parts of mechanical and electrical equipment shall be protected from damage during surface preparation and coating operations. Openings in motors shall be masked to prevent entry of coating or other materials.

D. Care shall be exercised not to damage adjacent Work during blasting operations. Spraying shall be conducted under carefully controlled conditions. The Contractor shall be fully responsible for and shall promptly repair any and all damage to adjacent Work or adjoining property occurring from blasting or coating operations.

E. Protection of Painted Surfaces: Cleaning and coating shall be coordinated so that dust and other contaminants from the preparation process will not fall on wet, newly-coated surfaces.

3.05 ENVIRONMENTAL REQUIREMENTS

A. No coating work shall be performed under the following conditions:

1. Surface or ambient temperatures exceed the manufacturer's recommended maximum or minimum allowable.

2. Dust or smoke laden atmosphere.

3. Damp or humid conditions, where the relative humidity is above the manufacturer's maximum allowable.

4. Substrate and ambient temperatures are less than 5°F above the dew point and are decreasing. Dew point shall be measured by use of an instrument such as a Sling Psychrometer in conjunction with U.S. Department of Commerce, Weather Bureau psychrometric tables. Elcometer 319 Dew Point meter or equal may also be used.

5. Ambient temperature that is expected to drop below 50 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

3.06 SURFACE PREPARATION STANDARDS

A. The following referenced surface preparation specifications of the Steel Structures Painting Council shall form a part of this specification:

1. Solvent Cleaning (SSPC SP 1): Removal of oil, grease, soil, salts, and other soluble contaminants by cleaning with solvent, vapor, alkali, emulsion, or steam.

2. Hand Tool Cleaning (SSPC SP 2): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by hand chipping, scraping, sanding, and wire brushing.

3. Power Tool Cleaning (SSPC SP 3): Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, by power tool chipping, descaling, sanding, wire brushing, and grinding.

4. White Metal Blast Cleaning (SSPC SP 5/NACE 1): Removal of all visible rust, oil, grease, soil, dust, mill scale, paint, oxides, corrosion products and foreign matter by blast cleaning.

5. Commercial Blast Cleaning (SSPC SP 6/NACE 3): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 33 percent of each square inch of surface area.

6. Brush-Off Blast Cleaning (SSPC SP 7/NACE 4): Removal of all visible oil, grease, soil, dust, loose mill scale, loose rust, and loose paint.

7. Near-White Blast Cleaning (SSPC SP 10/NACE 2): Removal of all visible oil, grease, soil, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except that staining shall be limited to no more than 5 percent of each square inch of surface area.

8. Power Tool Cleaning to Bare Metal (SSPC 11) When viewed without magnification, the surface shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portion of pits if the original surface is pitted. The surface profile shall not be less than 1 mil (25 microns).

9. Surface Preparation of Concrete (SSPC-SP 13/NACE 6): Removal of protrusions, laitance and efflorescence, existing coatings, form-release agents, and surface contamination by detergent or steam cleaning, abrasive blasting, water jetting, or impact or power tool methods as appropriate for the condition of the surface and the requirements of the coating system.

3.07 FERROUS METAL SURFACE PREPARATION (UNGALVANIZED)

A. The minimum abrasive blasting surface preparation shall be as indicated in the coating system schedules included at the end of this Section. Where there is a conflict between these requirements and the coating manufacturer's printed recommendations for the intended service, the higher degree of cleaning shall apply.

B. The Shop Painting Facility shall use a minimum blast material mixture of 75 percent grit and 25 percent shot material to achieve the proper surface profile.

C. The Field Coating Applicator shall abrasive blast the shop coated surfaces per SSPC SP 7/NACE 4. The previously shop-painted surfaces shall be abraded prior to the application of the final coats. Special attention shall be given to uncoated steel weld joints, coating holdbacks, and bare metal.

D. Grease, oil, and welding fluxes shall be removed by wiping with MEK or naphtha cleaning or with trisodium phosphate detergent per SSPC SP 1.

E. All sharp edges shall be rounded or chamfered and all burrs, rust, scale, welding slag, and spatter shall be removed, and the surface prepared by SSPC SP 2 hand tool cleaning, and SSPC SP 3 power tool cleaning.

F. The Contractor shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any blasted surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter ($\mu g/cm^2$). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

G. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate’s surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

H. The type and size of abrasive shall be selected to produce a surface profile that meets the coating manufacturer's recommendation for the particular coating and service conditions. Abrasive shall not be reused unless an automated blasting system is used for surfaces that will be in non-submerged service. For automated blasting systems, clean oil-free abrasives shall be maintained. The abrasive mix shall include at least 50 percent grit.

I. The Contractor shall comply with the applicable federal, state, and local air pollution control regulations for blast cleaning.

J. Compressed air for air blast cleaning shall be supplied at adequate pressure from well-maintained compressors equipped with oil and moisture separators that remove at least 95 percent of the contaminants.

K. Surfaces shall be cleaned of dust and residual particles of the cleaning operation by dry air blast cleaning, vacuuming, or another approved method prior to painting.

L. Enclosed areas and other areas where dust settling is a problem shall be vacuum-cleaned and wiped with a tack cloth.

M. Damaged or defective coating shall be removed by the blast cleaning to meet the clean surface requirements before recoating.

N. If the required abrasive blast cleaning will damage adjacent Work, the area to be cleaned is less than 100 square feet, and the coated surface will not be submerged in service, then SSPC SP 2 or SSPC SP 3 may be used.

O. Shop-applied coatings of unknown composition shall be completely removed before the indicated coatings are applied. Valves, castings, ductile or cast iron pipe, and fabricated pipe or equipment shall be examined for the presence of shop-applied temporary coatings. Temporary coatings shall be completely removed by solvent cleaning per SSPC SP 1 before the abrasive blast cleaning has been started.

P. Shop primed equipment shall be solvent-cleaned in the field before finish coats are applied.

3.08 FERROUS METAL SURFACE PREPARATION (GALVANIZED)

A. Galvanized ferrous metal shall be alkaline cleaned per SSPC SP 1 to remove oil, grease, and other contaminants detrimental to adhesion of the protective coating system, followed by brush off blast cleaning per SSPC SP 7/NACE 4.

B. Any high spots, sharp protrusions, and rough edges, such as the metal drip line, shall be smoothed to avoid paint film gaps in the areas of the high spots. Surfaces shall be hand tool cleaned per SSPC SP 2 and power tool cleaned per SSPC SP 3.

C. Pretreatment coatings of surfaces shall be in accordance with the printed recommendations of the coating manufacturer. Galvanized metals may be cleaned with suitable organic solvent such as a rust inhibitor or aqueous alkaline solution per ASTM D6386.

D. The surfaces of galvanized steel exposed to chemical splashing or within a wastewater head space shall be abraded per SSPC SP 11 or SP 7 prior to coating.

3.09 SURFACE PREPARATION OF FERROUS SURFACES WITH EXISTING COATINGS, EXCLUDING STEEL RESERVOIR INTERIORS

A. General: Grease, oil, heavy chalk, dirt, or other contaminants shall be removed by solvent or detergent cleaning prior to abrasive blast cleaning. The generic type of the existing coatings shall be determined by laboratory testing.

B. Abrasive Blast Cleaning: The Contractor shall provide the degree of cleaning indicated in the coating system schedule for the entire surface to be coated. If the degree of cleaning is not indicated in the schedule, deteriorated coatings shall be removed by abrasive blast cleaning to SSPC SP 6/NACE 3. Areas of tightly adhering coatings shall be cleaned to SSPC SP 7/NACE 4, with the remaining thickness of existing coating not to exceed 3-mils.

C. Incompatible Coatings: If coatings to be applied are not compatible with existing coatings the Contractor shall apply intermediate coatings per the manufacturer's recommendation for the indicated coating system or shall completely remove the existing coating prior to abrasive blast cleaning. A small trial application shall be conducted for compatibility prior to painting large areas.

D. Unknown Coatings: Coatings of unknown composition shall be completely removed prior to application of new coatings.

E. Water Abrasive or Wet Abrasive Blast Cleaning: Where indicated or where Site conditions do not permit dry abrasive blasting for industrial coating systems due to dust or air pollution considerations, water abrasive blasting or wet abrasive blasting may be used. In both methods, paint-compatible corrosion inhibitors shall be used, and coating application shall begin as soon as the surfaces are dry. Water abrasive blasting shall be done using high pressure water with sand injection. In both methods, the equipment used shall be commercially produced equipment with a successful service record. Wet blasting methods shall not be used for submerged or severe service coating systems unless indicated.

3.10 CONCRETE AND CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. Surface preparation shall not begin until at least 30 Days after the concrete or masonry has been placed. All water retaining structures shall be successfully leak tested prior to coating application.

B. At the discretion of the Inspector, the Contractor shall test the surfaces for soluble salts with the use of Chlor*Test as manufactured by Chlor*Rid International or approved equivalent. Any surfaces shall be tested and shall have a maximum concentration of 5 micrograms per square centimeter (µg/cm2). A test shall be conducted for every 100 square feet (ft2) of surface area to be coated at locations determined by the Inspector.

C. If the soluble salt test indicates chloride concentrations greater than those outlined in these Specifications, the Contractor shall use Chlor*Rid, as manufactured by Chlor*Rid International, in the water source during Water Cleaning to remove the salts from the substrate. A substrate’s surface preparation will be accepted once the soluble salt concentration is below the amounts outlined in these Specifications.

D. In accordance with ASTM D4262, test to determine the pH of the concrete surface after the surface has been thoroughly blasted and cleaned. If the pH is outside the range recommended by the coating manufacturer, then the surface must be neutralized by removing concrete until the surface pH of 7 or greater is obtained prior to any coating application. One pH test shall be performed every 200 square feet, or less, and at locations determined by the Inspector.

E. The Contractor shall test for capillary moisture in accordance with ASTM D4263. Moisture tests shall be taken every 200 square feet or less and at locations determined by the Inspector. If capillary moisture is present, the coating manufacturer shall be consulted to determine primer requirements and special coating application criteria.

F. For below grade structures with surface areas greater than 2,000 square feet, the Contractor shall install three anhydrous calcium chloride test kits on bare concrete to measure the Moisture Vapor Transmission Rate (MVTR) on a flat horizontal surface. Testing and calculations shall be performed according to ASTM F1869. The MVTR shall be less than 3 lbs per 1,000 square feet per 24 hours. If the MVTR is greater than 3 lbs per 1,000 square feet per 24 hours, the Contractor shall apply a concrete sealant to reduce the MVTR through the concrete. The test kits shall be undisturbed for a minimum of 60 hours.

G. Surface Voids: Bugholes, honeycomb, or other surface voids greater than 1/4 inch in depth or 1/4 inch in diameter shall be filled in with a resurfacing mortar prior to the application of any primer or finish coat.

H. Holes or other joint defects in masonry shall be filled with mortar and repainted. All voids and cracks shall be repaired as specified. Loose or spatter mortar shall be removed by scraping and chipping. Masonry surfaces shall be cleaned with clear water by washing and scrubbing to remove foreign and deleterious substances. Muriatic acid shall not be used. After cleaning, masonry surfaces shall be sealed or filled with a sealer or block filler compatible with the specified primer.

I. Coating Pipe Penetrations: A 1/4-inch wide by 3/8-inch deep saw cut shall be made around the circumference of the pipe as it penetrates the concrete. Prior to the coating application, the saw cut shall be dried and vacuumed to remove all dust and residue.

J. Coating Floor/Wall Joints: A 1/4-inch wide by 3/8-inch deep saw cut shall be made on the vertical and horizontal concrete surfaces around the perimeter of the floor. The saw cut shall be 2 inches from the joint on both sides. Prior to the coating application, the saw cut shall be dried and vacuumed to remove all dust and residue.

K. All oil, grease, and form release and curing compounds shall be removed by detergent cleaning per SSPC-SP 1 before abrasive blast cleaning.

L. New concrete, concrete block masonry surfaces and deteriorated concrete surfaces to be coated shall be abrasive blast cleaned to remove existing coatings, laitance, and deteriorated concrete, and to roughen the surface equivalent to 80 Grit sandpaper or ICRI No. 310.2 Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays Concrete Surface Profile No. 4.

M. Surfaces shall be clean and as recommended by the coating manufacturer before coating is started.

N. Secondary Containment: Treat cracks, construction joints, expansion joints and inside corners according to the coating manufacturer’s recommendations.

3.11 PLASTIC, FIBER GLASS AND NONFERROUS METALS SURFACE PREPARATION

A. Plastic and fiber glass surfaces shall be sanded or brush off blast cleaned prior to solvent cleaning with a chemical compatible with the coating system primer.

B. Non-ferrous metal surfaces shall be solvent-cleaned SSPC SP 1 followed by sanding or brush-off blast cleaning SSPC SP 7/NACE 4.

C. Surfaces shall be clean and dry prior to coating application.

3.12 ARCHITECTURAL CONCRETE BLOCK MASONRY SURFACE PREPARATION

A. The mortar surfaces shall be cured at least 14 Days before surface preparation Work is started.

B. Dust, dirt, grease, and other foreign matter shall be removed prior to abrasive blasting.

C. The masonry surfaces shall be prepared in accordance with the material manufacturer's printed instructions.

3.13 SHOP COATING REQUIREMENTS

A. Unless otherwise indicated, items of equipment or parts of equipment which are not submerged in service shall be shop-primed and then finish-coated in the field after installation with the indicated or selected color. The methods, materials, application equipment, and other details of shop painting shall comply with this Section. If the shop primer requires top coating within a specific period of time, the equipment shall be finish-coated in the shop and then be touched up after installation.

B. Items of equipment or parts and surfaces of equipment which are submerged or inside an enclosed hydraulic structure when in service, with the exception of pumps and valves, shall have surface preparation and coating performed in the field.

C. Shop primed surfaces which are to be incorporated in the work shall be prepared in the field by cleaning all surfaces as necessary in accordance with SSPC SP 1 and SP 2. Damaged shop coating shall be cleaned in accordance with SSPC SP 3, Power Tool Cleaning, and recoated with the primer specified.

D. For every 500 square feet, or less, of steel surface blasted, the surface profile shall be tested with the use of Press-o-Film as manufactured by Testex, or other RP0287 approved equal, at locations to be determined by the Inspector. The replica tape thickness shall be measured using a dial micrometer manufactured by Testex, or other ASTM D4417 Type C approved equal. For each test area, one replica tape test shall be performed. For each test area, the three replica tape thickness values shall be recorded and must be within 10 percent of the coating manufacturer’s recommended profile. If the surface profile does not meet the manufacturer’s recommended profile, two additional tests will be performed within a 12-inch diameter of the initial test. If the values are not satisfactory, the Contractor shall reblast the affected areas.

E. The interior surfaces of steel water reservoirs, except for Paragraph A surfaces, shall have surface preparation and coating Work performed in the field.

F. For certain pieces of equipment, it may be undesirable or impractical to apply finish coatings in the field. Such equipment may include engine generator sets, equipment such as electrical control panels, switchgear or main control boards, submerged parts of pumps, ferrous metal passages in valves, or other items where it is not possible to obtain the indicated quality in the field. Such equipment shall be primed and finish-coated in the shop and touched up in the field with the identical material after installation. The Contractor shall require the manufacturer of each such piece of equipment to certify as part of its Shop Drawings that the surface preparation is in accordance with these specifications. The coating material data sheet shall be submitted with the Shop Drawings for the equipment.

G. For certain small pieces of equipment, the manufacturer may have a standard coating system that is suitable for the intended service conditions. In such cases, the final determination of suitability will be made during review of the Shop Drawing submittals. Equipment of this type generally includes only indoor equipment such as instruments, small compressors, and chemical metering pumps.

H. Shop-painted surfaces shall be protected during shipment and handling by suitable provisions including padding, blocking, and the use of canvas or nylon slings. Primed surfaces shall not be exposed to the weather for more than 2 months before being top coated or less time if recommended by the coating manufacturer.

I. Damage to shop-applied coatings shall be repaired in accordance with this Section and the coating manufacturer's printed instructions.

J. The Contractor shall make certain that the shop primers and field topcoats are compatible and meet the requirements of this Section. Copies of applicable coating manufacturer's data sheets shall be submitted with equipment Shop Drawings.

3.14 APPLICATION OF COATINGS

A. The application of protective coatings to steel substrates shall be in accordance with SSPC PA 1 - Paint Application Specification No. 1.

B. Cleaned surfaces and each coat shall be inspected prior to applying each succeeding coat. The Contractor shall schedule such inspection with the Engineer in advance.

C. Blast cleaned ferrous metal surfaces shall be painted before any rusting or other deterioration of the surface occurs. Blast cleaning shall be limited to only those surfaces that can be coated in the same day.

D. Coatings shall be applied in accordance with the manufacturer's instructions and recommendations and this Section, whichever has the most stringent requirements.

E. Special attention shall be given to edges, angles, weld seams, flanges, nuts and bolts, and other places where insufficient film thicknesses are likely to be present. Contractor shall use an independent stripe coat per SSPC PA Guide 11 for these areas. Particular care shall be used to ensure that the specified coverage is secured on the edges and corners of all surfaces.

F. Special attention shall be given to materials that will be joined so closely that proper surface preparation and application are not possible. Such contact surfaces shall be coated prior to assembly or installation.

G. Finish coats, including touch-up and damage repair coats shall be applied in a manner that will present a uniform texture and color matched appearance.

H. Coatings shall not be applied under the following conditions:

1. Temperatures exceeding the manufacturer's recommended maximum and minimum allowable.

2. Concrete surfaces will be in direct sunlight during application or within 3 hours after application.

3. Dust or smoke laden atmosphere.

4. Damp or humid weather.

5. Substrate or air temperature is less than 5 degrees F above the dew point.

6. Air temperature is expected to drop below 40 degrees F or less than 5 degrees F above the dew point within 8 hours after application of coating.

7. Wind conditions are not calm.

I. Dew point shall be determined by use of a sling psychrometer in conjunction with U.S. Dept. of Commerce, Weather Bureau psychometric tables.

J. Unburied steel piping shall be abrasive blast cleaned and primed before installation.

K. Finish coats shall be applied after concrete, masonry, and equipment installation is complete, and the working areas are clean and dust free.

3.15 CURING OF COATINGS

A. The Contractor shall maintain curing conditions in accordance with the conditions recommended by the coating material manufacturer or by this Section, whichever is the most stringent, prior to placing the completed coating system into service.

B. In the case of enclosed areas, forced air ventilation, using heated air if necessary, may be required until the coatings have fully cured.

3.16 IDENTIFICATION OF PIPING

A. Every valve or connection, where it may be possible for a worker to be exposed to a hazardous substance, shall be labeled per General Industry Safety Orders, Articles 112 and 5194 OSHA Occupational Safety and Health Standards 29CFR1910.1200.

B. Unburied pipes in structures and in chemical pipe trenches shall be color-code painted. Colors shall be as selected by the Engineer or as indicated.

C. Unburied chemical pipes, including chemical pipes in structures and chemical pipe trenches, shall be color-code painted. Colors shall be as selected by the Engineer or as indicated.

3.17 SHOP AND FIELD INSPECTION AND TESTING

A. General: The Contractor shall give the Engineer a minimum of 3 Days advance notice of the start of any field surface preparation or coating application, and a minimum of 7 Days advance notice of the start of any surface preparation activity in the shop.

B. Such Work shall be performed only in the presence of the Engineer, unless the Engineer has granted prior approval to perform such Work in its absence.

C. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, shall not relieve the Contractor of its responsibility to perform the Work in accordance with these Specifications.

D. Scaffolding shall be erected and moved to locations where requested by the Engineer to facilitate inspection. Additional illumination shall be furnished on areas to be inspected.

E. Inspection Devices: The Contractor shall furnish inspection devices in good working condition for the detection of holidays and measurement of dry film thicknesses of coatings. Dry-film thickness gauges shall be made available for the Engineer's use while coating is being done, until final acceptance of such coatings. The Contractor shall furnish the services of a trained operator of the holiday detection devices until the final acceptance of such coatings. Holiday detection devices shall be operated only in the presence of the Engineer.

F. Holiday Testing: The Contractor shall test for continuity all coated ferrous surfaces inside a steel reservoir, other surfaces that will be submerged in water or other liquids, surfaces that are enclosed in a vapor space in such structures, and surfaces coated with any of the submerged and severe service coating systems. Areas that contain discontinuities shall be marked and repaired or recoated in accordance with the coating manufacturer's printed instructions and then be retested.

1. Coatings with thickness exceeding 20-mils total DFT: Pulse-type holiday detector such as **Tinker & Rasor Model AP-W, D.E. Stearns Co. Model 14/20,** or equal shall be used. The unit shall be adjusted to operate at the voltage required to cause a spark jump across an air gap equal to twice the required coating thickness.

2. Coatings with thickness of 20-mils or less total DFT: **Tinker & Rasor Model M1** non-destructive type holiday detector, **K-D Bird Dog,** or equal shall be used. The unit shall operate at less than 75 volts. For thicknesses between 10- and 20-mils, a non-sudsing type wetting agent, such as **Kodak Photo-Flo** or equal, shall be added to the water prior to wetting the detector sponge.

G. Film Thickness Testing: On ferrous metals, the dry film coating thickness shall be measured in accordance with the SSPC Paint Application Specification No. 2 using a magnetic type dry film thickness gauge such as **Mikrotest Model FM, Elcometer Model 111/1EZ,** or equal. Each coat shall be tested for the correct thickness. No measurements shall be made until at least 8 hours after application of the coating. On non-ferrous metals and other substrates, the coating thicknesses shall be measured at the time of application using a wet film gauge.

H. Surface Preparation: Confirm proper surface profile with Testex Press-O-Film replica tape in accordance with NACE RP0287-02.

3.18 COATING SYSTEM SCHEDULE, FERROUS METAL - NOT GALVANIZED

	Item	**Surface Prep.**	**System No.**
FM-1	All surfaces indoors and outdoors, exposed or covered, except those included below.	Commercial blast cleaning SSPC SP 6/NACE 3	(4) epoxy/ polyurethane
FM-3	Surfaces of equipment and ferrous surfaces submerged or intermittently submerged in potable water, utility water, and wastewater including all surfaces lower than 2 feet above high water level in hydraulic structures, and all surfaces inside enclosed hydraulic structures and vents (excluding shop-coated valves, couplings, pumps).	White metal blast cleaning SSPC SP 5/NACE 1	(100) amine cure epoxy
FM-7	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FM-8	Where indicated, ferrous surfaces in water passages of all valves 2-inch size and larger, exterior surfaces of submerged valves.	White metal blast cleaning SSPC SP 5/NACE 1	(102) polyamide epoxy
FM-9	Where indicated, ferrous surfaces in water passages and submerged surfaces of all pumps which have discharge size of 4 inches or larger.	White metal blast cleaning SSPC SP 5/NACE 1	(100) amine cure epoxy
FM-10	Ferrous surfaces of sleeve couplings.	Solvent cleaning SSPC SP 1, followed by white metal blast cleaning SSPC-SP 10/NACE 2	(106) fusion bonded epoxy
FM-12	Buried surfaces that are not indicated to be coated elsewhere.	Near white metal blast cleaning SSPC SP 10/NACE 2	(100) amine cure epoxy

FM-15	Structural steel, miscellaneous metalwork, and supports for prefabricated metal buildings.	*See Specification 13 34 19*	

FM-17	Surfaces of indoor equipment, not submerged	Commercial blast cleaning SSPC SP 6/NACE 3	(8) epoxy, equipment
FM-19	Buried pipe couplings, valves, fittings, and flanged joints (where piping is plastic).	Removal of dirt, grease, oil	(201) rich portland cement mortar
FM-20	Buried pipe couplings, valves, and flanged joints (where piping is ductile or cast iron, not tape-coated), including factory-coated surfaces.	As specified by reference specification	(205) polyethylene encasement
FM-21	Buried pipe couplings, valves, and flanged joints (where piping is mortar-coated steel or reinforced concrete), including factory-coated surfaces.	Removal of dirt, grease, oil	(206) cement mortar coating

3.19 COATING SYSTEM SCHEDULE, FERROUS METAL - GALVANIZED: PRETREATMENT COATINGS, BARRIER COATINGS, OR WASHES SHALL BE APPLIED AS RECOMMENDED BY THE COATING MANUFACTURER. ALL GALVANIZED SURFACES SHALL BE COATED. ALL GALVANIZED SURFACES SHALL BE COATED EXCEPT FOR THE FOLLOWING ITEMS WHICH SHALL BE COATED ONLY IF REQUIRED BY OTHER SECTIONS: (1) FLOOR GRATINGS AND FRAMES, (2) HANDRAILS, (3) STAIR TREADS, (4) CHAIN LINK FENCING AND APPURTENANCES.

	Item	**Surface Prep.**	**System No.**
FMG-1	All exposed surfaces indoors and outdoors, except those included below.	Solvent cleaning SSPC SP 1	(4) epoxy/ polyurethane
FMG-3	Buried small steel pipe.	Removal of dirt, grease, oil	(200) PVC tape
FMG-4	Surfaces buried or submerged in water or wastewater, including all surfaces lower than two feet above high water level and all surfaces inside enclosed hydraulic structures and vents.	Solvent cleaning SSPC SP 1 followed by brush-off grade blast cleaning SSPC SP 7/NACE 4	(100) amine cure epoxy

3.20 COATING SYSTEM SCHEDULE, STEEL WATER RESERVOIR INTERIOR**:** FOR STEEL WATER RESERVOIR EXTERIOR COATING SYSTEM, SEE "COATING SYSTEM SCHEDULE, FERROUS METAL-NOT GALVANIZED." THE INTERIOR SURFACES OF STEEL WATER RESERVOIRS SHALL HAVE SURFACE PREPARATION AND COATING WORK PERFORMED IN THE FIELD.

	Item	**Surface Prep.**	**System No.**
SR-1	Interior surfaces including plates, lap roof plate edges (both sides), roof structural members, fittings, piping within the reservoir, and vents, undersides of column bases, floor under column bases before columns have been set in place, submerged contact surfaces that are not accessible	SSPC SP 10/NACE 2	(105) Epoxy, Steel Reservoirs

	after erection. The interior and exterior surfaces of the overflow, drain, inlet, outlet, and all piping under the reservoir shall be coated in accordance with the requirements of Section 33 05 24.23 02511 – Steel Pipe for Water Service.		

3.21 COATING SYSTEM SCHEDULE, INTERIOR SURFACES OF WELDED STEEL TANKS: FOR STEEL TANK EXTERIOR COATING SYSTEMS, SEE "COATING SYSTEM SCHEDULE, FERROUS METAL-NOT GALVANIZED":

Product Stored	**Surface Prep.**	**System No.**
Zinc orthophosphate	White metal blast cleaning SSPC SP 5/NACE 1	(107) Natural rubber (soft) or neoprene
Liquid alum	White metal blast cleaning SSPC SP 5/NACE 1	(107) Natural rubber (soft) or neoprene
Polymer	White metal blast cleaning SSPC SP 5/NACE 1	(107) Natural rubber (soft) or neoprene
Sodium bisulfite	White metal blast cleaning SSPC SP 5/NACE 1	(107) Natural rubber (soft) or neoprene
Ferric chloride	White metal blast cleaning SSPC SP 5/NACE 1	(107) Natural rubber (hard)
Aqueous ammonia	White metal blast cleaning SSPC SP 5/NACE 1	(107) Chlorobutyl rubber
Caustic soda	Commercial blast cleaning SSPC SP 6/NACE 3	No coating
Sodium hypochlorite	White metal blast cleaning SSPC SP 5/NACE 1	(107) Chlorobutyl rubber
Sulfuric acid (maximum 50 percent concentration)	White metal blast cleaning SSPC SP 5/NACE 1	(107) EPDM or Hypalon
Hydrofluosilicic acid	White metal blast cleaning SSPC SP 5/NACE 1	(107) Chlorobutyl rubber
Water, potable water, utility water	White metal blast cleaning SSPC SP 5/NACE 1	(100) Amine-cured epoxy

3.22 COATING SYSTEM SCHEDULE-CONCRETE

	Item	**Surface Prep.**	**System No.**
C-1	All surfaces indoors and outdoors, where indicated.	Per paragraph 3.10	(108) polyurethane, concrete
C-3	Floor slab and walls, exposure to chemicals, where indicated.	Per paragraph 3.10	(211) Novolac Epoxy, Concrete

C-6	Indoor secondary chemical containment curbs.	Per paragraph 3.10	(211) Novolac Epoxy, Concrete. Color to be safety yellow.

3.23 COATING SYSTEM SCHEDULE – MISCELLANEOUS SURFACES

	Item	**Surface Prep.**	**System No.**
MS-1	Wood, indoors and outdoors, and gypsum board indoors.	Per manufacturer's printed instructions	(210) acrylic
MS-2	Containerized Membrane Filtration Trailer exterior sheet metal.	Per manufacturer's printed instructions	(1) Acrylic Polymer. Color to be the same as prefabricated metal building wall panels.

END OF SECTION

SECTION 10 14 00 – BUILDING SIGNAGE

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Building signages

1.02 .REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Reference Standards

Americans with Disabilities Act (ADA): ADA Accessibility Guidelines (ADAAG)	
Building Code	
	Refer to the Drawings to determine which Building Code applies. The applicable Building Code, defined by the Drawings, is referred to herein as “the Code.”
National Fire Protection Association (NFPA)	
NFPA 704	Identification of the Hazards of Materials for Emergency Response
Occupational Safety and Health Administration (OSHA)	

1.03 SUBMITTALS

A. Product Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions, and the following:

a. Manufacturer’s full range color charts, indicating custom color availability for color selection by Owner.

B. Certificates:

1. Certification by the building signage Manufacturer that the building signage provided is suitable for, and compatible with, the required installation.

2. Certification by the building signage Manufacturer that the building signage provided is suitable for, and compatible with, the substrates and surfaces indicated.

3. Certification of Manufacturer qualifications demonstrating compliance with the qualifications requirements indicated.

4. When requested by the Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Shop Drawings shall be drawn to sufficient scale and shall include dimensions, show elevations and details of construction of each building signage type, schedule of building signage, mounting details, location and installation requirements, thickness of materials, joints, provisions for expansion and contraction, connections, accessories, and trim.

D. Samples:

1. The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

2. Full-size sample of each typical building signage type.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Building signage shall be provided by a single Manufacturer, unless otherwise indicated.

B. Qualifications:

1. Manufacturers:

a. Building signage Manufacturer shall have a minimum of 10 years of building signage manufacturing experience.

b. Manufacturers without these qualifications will not be accepted.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish Manufacturer's 15-year written warranty to cover defects in materials, products, and manufacturing workmanship.

a. Warranty shall include coverage against chipping, fading, rusting, shattering, or peeling.

2. Warranties shall be non-prorated for the entire warranty period.

3. The term of the warranties shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Building signage shall be recommended by the Manufacturer for the installation indicated.

B. Building signage shall be suitable for, and compatible with, the required installation.

C. Building signage shall be suitable for, and compatible with, the substrates and surfaces indicated.

2.02 RESTRICTIVE/CAUTION SIGNS

A. Manufacturer and Product, or Equal:

1. Subject to the requirements indicated, provide Manufacturer and product listed below, or equal:

a. Seton UltraTuff by Seton

b. Branford, Connecticut

B. Description:

1. Signs shall be constructed of a printed polyester film permanently bonded to a rigid fiberglass panel and over-laminated with Tedlar by Seton, or approved equal, and a total thickness of 0.11-in minimum.

2. Signs shall be 14-in wide by 10-in tall in rounded corners. Color of signs and letters shall be in accordance with OSHA standards. All other aspects of the Restrictive/Caution Signs shall be in accordance with OSHA standards. If OSHA standards do not apply, the color shall be red with white letters, 1-in high.

3. Signs shall be wall and door surface mounted per Manufacturer standard. Signs shall be mounted as scheduled, as recommended in writing by the Manufacturer, and as approved by the Engineer.

4. Sign sizes shall be adjusted to suit the number of letters in each sign with a 1 ½-in minimum border all around. Two lines are permitted. Center justify the letters.

2.03 HAZARD IDENTIFICATION SYSTEM

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from the Manufacturer listed below, or equal.

a. Seton

b. Branford, Connecticut

B. Description:

1. System shall confirm to NFPA 704.

2. System shall use a diamond-shaped symbol divided into four smaller diamonds.

a. Health hazard diamond (left): blue background with a rating number in contrasting color.

b. Flammability hazard diamond (top): red background with a rating number in contrasting color.

c. Instability hazard diamond (right): yellow background with a rating number in contrasting color.

d. Special hazard diamond (bottom): white background with a rating number in contrasting color.

3. Colors used for the diamonds shall provide an adequate contrast so that the rating numbers are easily identified.

4. Signs mounted on walls and doors shall be high performances plastic signs.

5. Signs adhered to drums and containers shall be vinyl.

6. Unless otherwise noted, exterior signs shall be a minimum of 15-in by 15-in and interior signs shall be a minimum of 10-in by 10-in.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer’s original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer’s written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 LOCATIONS

A. Signage shall be installed at the locations indicated or as otherwise required by the Code, ADAAG, NFPA 704, and OSHA. Where a conflict occurs between the requirements of this Section and the references herein, the more stringent shall apply, as directed by the Engineer.

B. Where not indicated, signs shall be installed as directed by the Engineer.

C. Signs shall be mounted 60-in above the floor, unless otherwise indicated.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where building signage will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed building signage.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of building signage and appurtenances. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, with the requirements of the Code, NFPA 704, OSHA, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

C. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

D. Horizontal lines shall be level, and vertical lines shall be plumb.

E. The Contractor shall block and reinforce walls as required to support building signage, and appurtenances.

3.07 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, building signage and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Building signage shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When building signage Work is completed, remove unused materials, containers, and equipment, and clean the Site of building signage debris.

3.08 RESTRICTIVE/CAUTION SIGN SCHEDULE

Quantity	Sign Wording	Location
2 English	DANGER Equipment may start without warning	Others to be located by the Engineer.
3 English	NOTICE No Smoking	On all exterior doors. Located as directed by the Engineer.
3 English	EXIT	Locate on inside of each exit door. Others to be located by the Engineer.
2 English	CAUTION Non-Potable Water Do not drink	Locate at hose bibs where water is non-potable, and as directed by the Engineer.
3 English	EXIT DO NOT BLOCK DOOR	Exterior of each exterior door Others as directed by the Engineer.

3.09 HAZARDOUS IDENTIFICATION SYSTEM SIGN SCHEDULE – MEETING THE REQUIREMENTS OF NFPA 704

Quantity	Sign Wording	Location
1	0 2 0	Aluminum Chlorohydrate
1	0 2 0	Citric Acid

1	0 3 0 WR1 COR	Sodium Hydroxide
1	0 2 0	Sodium Hypochlorite
1	0 1 0	Calcium Thiosulfate

3.10 ADDITIONAL SIGNAGE

Quantity	**Sign Wording**	**Location**
	To Be Determined	To Be Determined

END OF SECTION

SECTION 10 28 13 – TOILET ACCESSORIES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Toilet and shower accessories.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

American National Standards Institute (ANSI)	
A117.1	Accessible and Useable Facilities
Americans with Disabilities Act (ADA)t	
ADAAG	Americans with Disabilities Accessibility Guidelines
Building Code	
	Refer to the Drawings to determine which building code applies within a given jurisdiction. The applicable building code, defined by the Drawings, is referenced herein as “the Code.”

1.03 SUBMITTALS

1. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certificates:

1. Certification by an independent testing organization demonstrating that grab bar strength and installation complies with the requirements indicated.

2. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and owner.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

D. Samples:

1. When requested by the Engineer, submit samples of the materials proposed. Samples shall be clearly marked to show the Manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the Samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1.05 CLOSEOUT SUBMITTALS

A. Warranty:

1. Submit a copy of the warranty.

1.06 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Toilet and shower accessories shall be provided from a single Manufacturer.

B. Qualifications:

1. Installers:

a. A minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

b. Installers without these qualifications will not be accepted.

1.07 WARRANTY

A. Manufacturer Warranty:

1. Furnish the Manufacturer's written 10 year warranty for mirrors to cover silver spoilage. The term of the warranty shall begin on the date of Substantial Completion.

PART 2 -- PRODUCTS

2.01 TOILET ACCESSORIES

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from one of the Manufacturers listed below, or Equal

a. Bobrick Washroom Equipment, Inc.

b. Bradley Corporation.

c. American Specialties, Inc.

B. Description:

1. Accessories shall be satin finish stainless steel unless otherwise indicated.

2. Grab bars shall be provided with peened gripping surface.

3. Provide items complete with screws, bolts, and anchoring devices required for proper installation.

4. Provide units complete with anchorages, reinforcements, backing, and blocking for securing the toilet and shower accessories to other Work.

2.02 ACCESSORIES SCHEDULE

A. Refer to the Drawings for locations and quantities of item numbers indicated below:

Item Number	Description	Manufacturer Product / Model Number, or Equal
GB36	36-in Grab Bar	BOBRICK MODEL B-6806.99 X 36
GB42	42-in Grab Bar	BOBRICK MODEL B-6806.99 X 42
SMTP	Surface Mounted Toilet Paper Dispenser	BOBRICK MODEL B-2888
PTWR	Surface Mounted Paper Towel Dispenser and Waste Receptacle	Bradley Corp Model 2028-11
SMSD	Surface Mounted Soap Dispenser	BOBRICK MODEL 818615
MS	Mirror, Channel Frame with Shelf (tempered glass)	BOBRICK MODEL B-1668 X 1836
SD	Soap Dish	BOBRICK MODEL B-6807
SN	Wall Mounted Sanitary Napkin Disposal	BOBRICK MODEL B-270

2.03 FABRICATION

A. The Contractor shall field verify size, location, and placement of toilet and shower accessories, shall advise the Engineer in writing of any necessary adjustments, and shall make the necessary adjustments prior to fabrication. The Contractor shall coordinate field measurements and shop drawings with fabrication and shop assembly to minimize field adjustments.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where toilet and shower accessories and related items will be installed for compliance with requirements for installation, taking into account tolerances, and other conditions affecting performance of installed toilet and shower accessories.

    a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of toilet and shower accessories. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.03 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with the requirements of The Code, ADAAG, and ANSI A 117.1 with applicable referenced standards, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

C. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

    1. Use fasteners appropriate to substrate as recommended in writing by the Manufacturer. Unless otherwise indicated, provide tamper-proof, theft-resistant, concealed mounting devices and fasteners, as recommended in writing by Manufacturer.

    2. Install units in locations and at heights indicated.

        a. Where heights and locations are not indicated, such items shall be installed where directed by the Engineer.

    3. Coordinate location of concealed supplemental blocking, backing, and additional anchoring reinforcement with items to be installed herein.

D. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

3.04 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking, which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Film and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, toilet and shower accessories and appurtenances shall be cleaned of all dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Toilet and shower accessories shall be protected from damage from subsequent construction operations.

D. The Contractor shall remove scratches and blemishes to the satisfaction of Engineer.

E. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

F. When toilet and shower accessories Work is completed, remove unused materials, containers, and equipment, and clean the Site of toilet and shower accessories debris.

END OF SECTION

SECTION 10 44 00 – FIRE EXTINGUISHERS

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire extinguishers

1.02 REFERENCE SECTIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Where reference is made to any of the below, the revision in effect at the time of bid opening shall apply.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

Building Code	
	Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as “the Code”.
National Fire Protection Association publications (NFPA)	
NFPA 10	Standard for Portable Fire Extinguishers
Underwriter’s Laboratories (UL)	

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Product Data:

1. Manufacturer’s specifications, technical data, installation methods, and maintenance instructions.

B. Certificates:

1. UL certification for each fire extinguisher unit provided.

2. Certification of Manufacturer qualifications demonstrating compliance with the qualification’s requirements indicated.

3. When requested by the Engineer, furnish other certifications as may be required to show compliance with the Contract Documents.

C. Shop Drawings:

1. Complete Shop Drawings showing location and detail of installation.

2. Shop Drawings shall include mounting and bracket details.

1.05 QUALITY ASSURANCE

A. Single Source Responsibility:

1. Fire extinguishers shall be provided by a single Manufacturer.

B. Qualifications:

1. Manufacturers:

a. Fire extinguisher Manufacturer shall have a minimum of 20 years of fire extinguisher manufacturing experience.

b. Manufacturers without these qualifications will not be accepted.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Fire extinguishers, accessories, and installation shall comply with the Code, NFPA 10, and with the Manufacturer's published recommendations and specifications.

2.02 FIRE EXTINGUISHERS

A. Manufacturer, or Equal:

1. Subject to the requirements indicated, provide products from one of the Manufacturers listed below, or Equal.

a. J.L Industries, Inc.

b. Larsen’s Manufacturing Co.

c. General Fire Extinguisher Co.

B. Description:

1. Fire extinguishers in every location, except in rooms or spaces containing electrical switchgear, motor control centers, variable frequency drives, generator rooms, etc., shall be 20 lb capacity, 6A:120BC (ABC), UL-rated, chemical multipurpose type.

2. Fire extinguishers in rooms or spaces containing electrical switchgear, motor control centers, variable frequency drives, generator rooms, etc., shall be 20 lb capacity 10 BC, UL-rated, carbon dioxide type.

3. Fire extinguishers shall be provided with severe duty corrosion resistant finish, red enamel steel cylinders.

4. Fire extinguishers shall be provided with mounting brackets, which support the bottom and sides of extinguishers, and are specially designed for the extinguisher, as recommended in writing by the Manufacturer.

2.03 ADDITIONAL EXTINGUISHERS

A. Provide 1 additional ABC units and 1 additional BC units to be located as directed.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in Manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

B. Store materials carefully in accordance with the Manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Handle materials in strict accordance with Manufacturer's written instructions.

3.02 LOCATIONS

A. The Contractor shall verify the fire extinguisher locations and mounting heights on the Contract Drawings with the Fire Marshal before installation. If locations on the Drawings are not accepted by the Fire Marshal, install fire extinguishers where directed by the Engineer.

3.03 PROJECT CONDITIONS

A. Comply with Manufacturer's written instructions for environmental conditions before, during, and after installation.

B. Protect surrounding Work from damage that may result from operations under this Section.

3.04 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

C. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where fire extinguishers and appurtenances will be installed for compliance with the requirements for installation, taking into account tolerances, and other conditions affecting performance of installed fire extinguishers and appurtenances.

a. Provide inserts, backing, blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of fire extinguishers and appurtenances. Coordinate delivery with other Work to avoid delay.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. Installation shall comply with the requirements of the Contract Documents, with applicable references, the requirements of the Code, with NFPA 10, and with Manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

B. The Contractor shall block and reinforce walls as required to support the fire extinguishers and appurtenances.

C. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

D. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

E. Horizontal lines shall be level, and vertical lines shall be plumb.

F. Secure mounting brackets and fire extinguishers to structure, square and plumb.

3.07 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation, fire extinguishers and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

1. Cleaning shall be performed again immediately prior to acceptance of the Work, when directed by the Engineer.

2. Cleaning shall be performed in accordance with the Manufacturer's written instructions.

C. Fire extinguishers shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When fire extinguishers Work is completed, remove unused materials, containers, and equipment, and clean the Site of fire extinguishers debris.

H. Fire extinguishers shall be inspected and certified within 30 days of Substantial Completion.

END OF SECTION

SECTION 10 51 13 – LABORATORY EQUIPMENT

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. Laboratory and related equipment.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Building Code: Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referred to herein as “the Code.”

B. All Work shall conform to or exceed the requirements of the Code.

C. Reference Specifications

01 33 00	Submittal Procedures
46 10 00	Equipment General Provisions

D. Reference Standards

American Conference of Governmental Industrial Hygienists (ACGIH)
American Industrial Hygiene Association (AIHA)
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)
ASTM International (ASTM)
Environmental Protection Agency (EPA)
Federal Specifications (FS)
National Fire Protection Association (NFPA)
Occupational Safety and Health Administration (OSHA)
Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
Underwriters Laboratory (UL).

1.03 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

1.04 ACTION SUBMITTALS

A. Manufacturer's Information:

1. The manufacturer's specifications, literature and published installation and maintenance instructions for each product. Submit for each item of laboratory equipment, the following: manufacturers' printed recommendations; installation instructions; specifications; operation manuals; engineering drawings, electrical drawings, plumbing drawings, and mechanical drawings; sales literature; material and color samples; statements of qualifications; lists of purchasers of similar units; and training materials as applicable.

2. Manufacturer’s information for the laboratory instruments shall be submitted prior to shipping as a compiled document with clear divisions or tabs for each instrument.

1.05 WARRANTY

A. Manufacturer Warranty:

1. Furnish copies of the manufacturer's warranties covering the items indicated within this Section in compliance with the requirements of Section 46 10 00 – Equipment General Provisions.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Each type of laboratory equipment item shall be the product of one manufacturer who specializes in production of these items.

2.02 LABORATORY FACILITIES

A. Fixtures:

1. Not Used

2.03 LABORATORY INSTRUMENT PRODUCTS

A. The following table includes laboratory instruments, approved product, quantity and applicable accessories to be furnished.

TABLE A: Laboratory Instruments

Instrument	Approved Product[1]	Accessories/ Consumables/Requirements	Quantity
UV254 Field Meter	RealTech P110T	- Measures in UVT - 10 mm path length option	1
Benchtop pH Meter with Probes and Stand	Oakton pH 700 EW-35419	- InnoCal NIST-Traceable Calibration; pH and Conductivity Meter, Handheld/Benchtop	1
Pocket Colorimeter for chlorine and pH	Hach/ DR300 EW-99573-82	- Free chlorine reagent powder pillows, 10 ml, pk/100	1

Portable Infrared Turbidity Meter Kit	Hach TU5 Series TU5200	- None	1
Variable Volume Pipette	Hach BBP065	- Volume range between 1.0-5.0 mL - Pipette tips, 100 pieces	1
Notes: [1]Product shall be as specified or approved equal.			

2.04 GENERAL USE SUPPLIES

A. The following table includes general use supplies/items, approved products, quantity and applicable accessories to be furnished.

TABLE B: General Use Supplies			
Item	Approved Manufacturer[1]	Accessories/ Consumables/Requirements	Quantity
Beaker, 50ml	Pyrex		1
Beaker, 100 ml	Pyrex		1
Beaker, 250 ml	Pyrex		1
Beaker, 600 ml	Pyrex		1
Beaker, 2L	Pyrex		1
Erlenmeyer flask, 100 ml	Pyrex		1
Graduated Cylinder, 50 ml	Pyrex		1
Graduated Cylinder, 1L	Pyrex		1
Magnetic Stirrer	Cole Parmer ST-200D-UT Ultra-Thin with Timer	- Include stir bar	1
First Aid Kit			1
Tweezers, General purpose	Fisherbrand		1
Notes: [1]Product shall be as specified or approved equal.			

PART 3 -- EXECUTION

3.01 PRODUCT DELIVERY, STORAGE, AND MATERIALS

A. Delivery of Equipment, Materials, and Products: Manufactured equipment, materials and products shall be delivered in original unbroken packages, containers, or bundles bearing the name of the manufacturer and product model name and numbers.

B. Storage: Equipment, materials, and products shall be carefully stored in an area which is protected from the deleterious elements in a manner recommended by the equipment manufacturer to prevent damage to the equipment, materials, and products and marring of the finishes.

C. If agreed between the Engineer, the Contractor, and the Owner, smaller items of laboratory equipment that do not require extensive installation may be furnished to an authorized representative of the Owner.

3.02 GENERAL

A. Laboratory equipment and related equipment items shall be installed in accordance with manufacturer's written instructions and recommendations for the specific applications and job conditions, unless more stringent requirements are indicated elsewhere.

3.03 SITE CONDITIONS

A. Laboratory equipment shall not be installed until the building is fully secured, enclosed, sufficient heat is provided, dust-generating activities have terminated, and overhead mechanical and electrical Work is completed and tested.

3.04 INSTALLATION

A. Not Used

3.05 WORKMANSHIP

A. Not Used

END OF SECTION

SECTION 13 34 19 – METAL BUILDING SYSTEMS

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide pre-engineered metal building(s) and appurtenant Work, complete and in place, with operational components, in accordance with the Contract Documents.

B. The Contractor shall furnish professional design and engineering services as required for pre-engineered metal building(s) and appurtenances as indicated herein.

1. Professional design and engineering services may be provided by the manufacturer or by an independent licensed professional engineer retained by the Contractor, either of which shall comply with the requirements indicated.

C. The Contractor shall coordinate color samples with other Sections through the submittal process.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 Washington State Building Code. If the standard is not referenced by the IBC, nor an IBC referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

C. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
09 96 00.10	High-Performance Coatings

D. Reference Standards

American Institute of Steel Construction (AISC)	
AISC 341	Seismic Provisions for Structural Steel Buildings
AISC 360	Specification for Structural Steel Buildings
AISC	Steel Construction Manual
American Iron and Steel Institute (AISI)	
AISI S100	North American Specification for the Design of Cold-Formed Steel Structural Members
American Society for Testing and Materials (ASTM)	
ASTM A36	Standard Specification for Carbon Structural Steel

ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A529	Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality
ASTM A572	Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM A1008	Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable
ASTM A1011	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F3125	Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength
American Welding Society (AWS)	
AWS D1.1	Structural Welding Code-Steel
AWS D1.3	Structural Welding Code - Sheet Steel
Factory Mutual Global (FM)	
FM Standard 4471	Approval Standard for Class 1 Roofs for Hail Damage Resistance, Combustibility, and Wind Uplift Resistance
International Code Council (ICC)	
IBC	2021 International Building Code with Washington amendments
Metal Building Manufacturer's Association (MBMA)	
	Metal Building Systems Manual
	Seismic Design Guide for Metal Building Systems.
The Society for Protective Coatings (SSPC)	
SSPC-SP 2	Hand Tool Cleaning
SSPC-SP 8	Pickling
Underwriters Laboratories (UL)	
UL 580	Standard for Tests for Uplift Resistance of Roof Assemblies

E. Building Code: Refer to the Drawings to determine which building code applies. The applicable building code, defined by the Drawings, is referenced herein as "the CODE."

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Literature: Manufacturer's specifications, technical data, installation methods, and maintenance instructions, and the following:

1. Complete operation instructions for operable components.

2. Manufacturer's full-range color charts, indicating custom color availability for color selection by the Owner.

3. Additional information for the building system, roof panels, wall panels, accessories and components.

C. Warranty: Submit a copy of the warranty.

D. Certifications

1. Certification of compliance with the Structural Requirements of paragraph 2.1.A.

2. Certification of manufacturer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, manufacturer's products, and contact information of the consultant firm of record, general contractor and owner.

3. Certification of installer qualifications demonstrating compliance with the qualifications requirements indicated. Include a list of 5 similar completed projects with addresses of the project location, date of project completion, and contact information of the consultant firm of record, general contractor and Owner.

4. Certification from the manufacturer stating that galvanizing has been completed in accordance with these specifications.

5. Certification of welder qualifications in accordance with AWS requirements.

6. Submit certification verifying that the metal roof system has been tested and approved by FM Standard 4471 as Class 1.

7. Submit certification verifying that the metal roof system has been tested and approved by UL 580 as Class 90.

8. When requested by the Engineer, furnish other certifications as may be required to demonstrate compliance with the Contract Documents.

E. Design Drawings and Design Calculations: Complete Design Drawings showing location and details of installation, and design calculations.

1. Design Drawings and Design Calculations shall be prepared, signed, and stamped by a professional civil or structural engineer registered in the State where the project is located.

2. Design Drawings shall be drawn to sufficient scale, showing fully-dimensioned layout, including plans, sections, elevations and details of construction, connections to the foundation, joints, penetration details, preformed metal closures, flashing, gutters, and downspouts, fastenings, system caulking, sealants, gaskets, appurtenances, locations of framed openings, special project specific conditions, location of custom-cut panels, provisions for expansion and contraction, doors, windows, louvers, connections, accessories, and trim.

    a. Design Drawings shall include material descriptions, finish, color, details of construction, installation, and accessories of each pre-engineered metal building and shall include, as a minimum:

        1) Erection drawings with written procedures to clearly explain proper installation of fasteners, trim, gaskets, and sealants. Erection drawings shall also include a notation requiring the installer to coordinate with other trades.

        2) Transverse cross sections.

        3) Roof plans showing sizes and locations of structural panels and connections.

        4) Elevations of walls showing sizes and locations of structural panels and connections, openings for doors, removable wall panels, HVAC and other mechanical and electrical equipment.

        5) Details of door, door frames, and other openings and accessories.

        6) Design and detail penetrations, including hot pipe penetrations, to be weathertight. Coordinate locations of penetrations.

        7) Manufacturer's standard details may be used in addition to the shop drawings listed above provided that the portions that apply are clearly marked and those parts that do not apply are clearly marked.

        8) Foundation and floor slab drawings.

            a) Foundation plan with anchor rods, shear lugs (if required) and base plate details. A diagram shall be included showing the vertical and lateral loads applied on the foundation for each load combination.

            b) Floor slab drawings shall show the location of all construction joints, blockouts and details of the interface between the foundation and floor slab.

3. Design Calculations

    a. Design calculations shall include a complete stress and deflection analysis of all structural components and connections.

b. Design calculations shall substantiate a complete load path for the wind and seismic lateral force resisting system including design of drag, collector and bracing elements (including connections) required to transfer loading, including overstrength factors, to the foundation. Detailing shall consider edge distance and clearance requirements at slab edges, blockouts and curbs.

4. Specifications for the painting system including paint manufacturer's name, product trade name, and preparation for shop and field coats.

F. Deferred Approval: The design drawings and design calculations are considered a delegated design/deferred approval item and shall be submitted to the Building Official(s) having jurisdiction for review and approval prior to construction. The Contractor shall provide all engineering support as necessary during the review process with all Building Official(s) having jurisdiction, including providing responses to review comments, attendance at meetings, and submitting all requested documentation.

G. Samples: The Contractor shall submit 2 samples of each of the following. Unless otherwise indicated, samples shall be full size and shall show gauges, configuration, construction, finish and color proposed for the various components. Samples shall be clearly marked to show the manufacturer's name, product identification, finish and color. New samples shall be resubmitted of each, as required, until approved by the Engineer. Upon approval, the samples shall become the standard for acceptance for the project with regard to color, finish, and quality of each item. Approval of samples shall not relieve the Contractor from compliance with the Contract Documents.

1. Metal Wall and Roof Panels

a. Assembled half panels, with representative panel support framing, showing seam, and appurtenances; 1 ft long, in color and finish indicated.

b. 3-in by 4-in color samples showing substrate, finish, and color.

2. Gutter and downspout: 1 ft long section of each in material, profile, finish, and color indicated.

3. Finish trim, closure pieces, and sealant, 1 ft long each.

4. Samples of each type fastener required, identified as to use.

1.04 QUALITY ASSURANCE

A. Single Source Responsibility: Pre-engineered metal buildings and components shall be provided by a single manufacturer.

B. Manufacturer Qualifications

1. Pre-engineered metal building manufacturer shall be a current member of the Metal Building Manufacturer's Association (MBMA).

2. Pre-engineered metal building manufacturer shall have a minimum of 20 years of Pre-engineered metal building manufacturing experience.

3. Pre-engineered metal building manufacturer shall have a minimum of 5 similar successful projects over the most recent 10 years, employing similar products, materials, applications, and performance requirements.

4. Manufacturers without these qualifications will not be accepted.

C. Installer Qualifications

1. Installer shall have a minimum of 5 years' experience in the successful completion of at least 5 projects of similar size and scope, employing similar products, materials, applications, and performance requirements.

2. Installer shall be trained, certified, and authorized by the manufacturer to install the manufacturer's product.

3. Installers without these qualifications will not be accepted.

1.05 SPECIAL WARRANTY PROVISIONS

A. For pre-engineered metal building(s) and appurtenances furnish manufacturer's 5-year written warranty to cover defects in materials, products, and manufacturing workmanship.

B. Installation Warranty: At the time of Substantial Completion, the manufacturer shall warrant that the installation is not defective and conforms to the manufacturer's erection drawings, except for reasonable variances not impairing the usefulness thereof.

C. Finish Warranty: The manufacturer shall warrant against spalling, fading, chalking, peeling, cracking, checking, chipping, or erosion to base metal of the exterior panel finish, for a period of 10 years from the date of Substantial Completion. The finish shall not change color more than eight NBS units for a period of 10 years from the date of Substantial Completion.

D. Weathertight Warranty: Manufacturer shall provide a weathertight warranty against water penetration of the pre-engineered metal building system, including panel joints and trim conditions for a period of 20 years from date of Substantial Completion.

E. In the event that the pre-engineered metal building fails to meet the warranty standards above, the manufacturer shall, at the manufacturer's sole cost (including labor and materials), replace or repair the pre-engineered metal building, as agreeable to the Owner throughout the term of the warranty.

F. The Contractor shall furnish separate, but concurrently running, 5-year written warranty to cover installation and associated labor.

G. The term of the warranties shall begin on the date of Substantial Completion, unless otherwise indicated.

PART 2 -- PRODUCTS

2.01 GENERAL

A. New Structural Requirements

1. Pre-engineered metal building(s), including structural framing, accessories, related assemblies, components, appurtenances and attachment details shall comply with the CODE and shall be designed and installed for resistance to the structural design criteria indicated in the Contract Documents in accordance with the CODE. Where a conflict occurs between the requirements of this Section and the CODE, the more stringent shall apply.

    a. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for additional design criteria.

2. The Contractor shall provide additional non-standard bracing, reinforcements, anchors, and heavier gauge materials in order to conform to the structural design criteria indicated and to other performance requirements indicated.

3. Pre-engineered metal building(s) including related assemblies, components, and accessories shall be manufactured and installed to maintain the specified performance requirements, under the structural design criteria indicated, without defects, damage, or failure.

B. Thermal Movements: Pre-engineered metal building(s) and accessories shall be designed to provide for such expansion and contraction of component materials as will be caused by temperature changes without causing buckling, stresses or other cladding components, failure of joints, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other visual or technical detrimental effects.

C. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

    a. Butler Manufacturing Company - With additional options and custom features as specified herein.

D. Description

1. Pre-engineered metal building(s) shall be provided complete, and shall include the structural framing, connections, anchor rods, framed openings for wall and penetrations, and framed openings for doors, windows and louvers; metal roofing and scrim faced insulation with metal wall panel system, gutters and downspouts, pipe flashing, gable trim, flashing, closures, fasteners, sealants, and all other component parts for a complete weathertight, exterior envelope. Building shall be fully insulated in walls and roof.

    a. Dimensions: The dimensions shall be as indicated on the Contract Documents. The minimum clear height to the underside of the roof members at their lowest

point (eave height) shall be as indicated on the Contract Documents. The roof slope shall be a minimum of ½-in per ft and meet code requirements.

b. Structural System

1) The building's structural system shall be a clear span rigid frame system in the as determined by the manufacturer and in coordination with the Contract Documents.

2) The building's structural system shall be selected such that it is compatible with the foundation system shown on the Contract Documents.

2.02 MATERIALS

A. Metals

1. Members fabricated from plate or bar stock: provide 42,000-psi minimum yield strength and comply with the requirements of ASTM A529, A1011, or A572.

2. Members fabricated by cold forming: ASTM A 1008, Grade 50.

3. Galvanized Steel Sheet: ASTM A 653 with G90 coating.

4. Bolts for Structural Framing: ASTM F3125.

5. Anchors into concrete: ASTM F1554 Grade 36 55 .

6. Hot rolled structural shapes: ASTM A36, A992, or A1011.

2.03 DESIGN CRITERIA

A. Design Loads

1. Roof live load, Wind load, and Seismic load shall be per the design criteria listed on the Structural General Notes Drawing S-001 .

2. Collateral loads shall include dead and live loads resulting from HVAC, piping, and other items suspended from the roof. This loading shall be coordinated with the drawings of all disciplines and manufacturer's shop drawings.

3. Crane loads shall be as required by the crane manufacturer for the crane capacity and type indicated on the Contract Documents, including impact and runway horizontal forces.

B. Design Requirements

1. Design structural panels and exterior covering materials for applicable loads and combinations of loads in accordance with the Metal Building Design Manual (MBMA).

2. For design of structural members, comply with the requirements of the AISC.

3. For design of light gage steel members, comply with AISC for design requirements and allowable stresses.

4. Welded connections shall comply with AWS.

5. Design framing to withstand stresses resulting from combinations of loads that produce the maximum allowable stresses in that member as prescribed in Metal Building Design Manual (MBMA).

6. The building shall be designed to withstand all loading conditions both with and without wall panels in place.

2.04 FOUNDATION AND FLOOR SLAB

A. The foundation and floor slab shall be reinforced concrete conforming to the requirements of the CODE and shall be provided by the Contractor.

B. The Contractor shall coordinate the details of anchorages of the pre-engineered metal building to its foundation. The Contractor shall provide the anchor rods and layout templates and allow for any foundation revisions necessary to adapt or support the pre-engineered metal building during construction as accepted by the Engineer.

2.05 STRUCTURAL FRAMING

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. Butler Manufacturing Company; Type LRF

B. Description

1. Design of the structural system for the pre-engineered metal building shall be a clear span rigid frame with tapered columns, tapered roof beams, and gable roof.

2. Primary Framing

a. Rigid Frames

1) Frames shall consist of welded plate section columns and roof beams complete with necessary splice plates for bolted field assembly.

2) Welding shall be performed in accordance with AWS requirements.

3) All base plates, cap plates, compression plates, and stiffener plates shall be factory-welded into place and have the connection holes shop fabricated.

4) All splice plates shall be shop fabricated complete with bolt connection holes.

5) Columns and roof beams shall be fabricated complete with holes in webs and flanges for the attachment of secondary structural members and bracing.

b. All bolts for field assembly of frame members shall be high strength bolts as indicated on erection drawings.

c. Endwall Structurals

1) Endwall frames shall consist of endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.

a) All splice plates and connection clips shall be shop fabricated complete with bolt connection holes.

b) Beams and posts shall be shop fabricated complete with holes for the attachment of secondary structural members.

3. Secondary Structural Members

a. Purlins and Girts

1) Purlins and girts shall be 8-in deep "Z" sections, precision roll formed.

2) Outer flange of all purlins and girts shall contain factory-punched holes for panel connections.

b. Eave Struts

1) Eave struts shall be 8-in deep "C" sections.

2) Outer flange of all eave struts shall contain factory-punched holes for panel connections.

c. Bracing

1) Diagonal bracing shall be designed by the building manufacturer and attached to columns and roof beams.

2) Flange braces, sag angles, etc., when required, shall be supplied by the building manufacturer.

3) All bracing locations shall be coordinated with ductwork, piping, door openings, and ventilation openings.

d. Secondary Framing

1) Provide framing for wall openings where windows, doors, ventilation equipment, and removable wall panels occur shall be stiffened flange channels and shall be provided by the prefabricated metal building manufacturer.

2) Base channel shall not be less than 14 gauge, shop painted cold-formed sections.

4. Structural Painting

a. Structural steel shall be shop prepared, shop primed, and field painted prior to erection. For additional requirements, see Section 09 96 00.10 – High-Performance Coatings. Primer products shall be compatible with paint system specified in Section 09 96 00.10 – High-Performance Coatings .

1) Primary Frames - Clean all steel per SSPC-SP2. Apply one coat of water reducible alkyd primer by spray or dip method to a minimum coating thickness of 1.0 mil.

2) Secondary Structurals - Clean all steel per SSPC-SP8. Apply one coat of coil applied polyester primer to a minimum coating thickness of 0.5 mil (purlins and grits).

2.06 METAL ROOF PANELS

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated, provide manufacturer and product listed below, or equal.

a. **METL SPAN**; CFR standing seam insulated metal roof panel.

B. Description

1. Standing Seam, Foamed-Insulation-Core Metal Roof Panels: Structural metal panels consisting of an exterior standing seam with an interior tongue and groove joint, coupled with a vapor seal in the standing seam, and provides superior resistance to air and moisture intrusion. Attached with concealed fasteners to the structure.

a. Basis of Design: Metl-Span**, CFR Insulated Metal Panel**.

b. G-90 Galvanized Coated Steel: ASTM A 653

2. Exterior Face: 24-gauge, Fluoropolymer system finish

3. Interior Face: 24-gauge, Fluoropolymer system finish

4. Endlaps: Provide panels with factory endlaps, notching, swedging and backer plates; where panel lengths permit.

5. Panel Width: 36 inches

6. Panel Thickness: 5 inches (U-Factor = 0.027)

2.07 METAL WALL PANELS

A. Manufacturer and Product, or Equal

1. Subject to the requirements indicated provide manufacturer and product listed below, or equal.

    a. **Butler Manufacturing Company**; Butler Thermawall Fineline Wall Systems

B. Description

1. Steel-faced, shop-assembled, factory-foamed, insulated panel units.

2. Double tongue-and-groove, side-joint design, with fasteners concealed within side joint.

3. Panel Thickness: 3 inches (U-Factor = 0.0424)

4. Panel Material and Finish:

    a. Corrugated Exterior-Faced Panels: 26-gauge, AZ50 aluminum-zinc coated steel.

    b. Interior Face: 26-gauge, AZ50 aluminum-zinc coated steel.

    c. Core: Poured-in-place polyurethane foam with a minimum 93 percent closed-cell structure.

    d. Exterior Panel Finish: Pre-finished with "Butler-Cote™" finish system, full-strength, 70 percent "Kynar 500" or "Hylar 5000" fluoropolymer (PVDF) coating in metal building system manufacturer's standard colors.

    e. Interior Panel Finish: Paint with USDA-approved interior white polyster paint.

2.08 METAL WALL AND ROOF PANEL FINISH AND COLOR

A. Finish: Exterior panel surface shall be Butler-Cote 500 FP (70% Kynar 500 fluoropolymer), or equal.

1. Interior surface finish shall be manufacturer's standard polyester paint finish on reverse face.

B. Color shall be selected and approved by the Owner from manufacturer's full color range including custom colors and may be required to exactly match other building components, as determined by the Owner, at no additional cost to the Owner.

1. Tentative color selection: Color shall exactly match colors indicated below, as selected and approved by the Owner.

Metal Roof Panels	
Exterior:	To Be Selected
Interior:	To Be Selected
Metal Wall Panels	
Exterior:	To Be Selected
Interior:	To Be Selected

2. The Owner reserves the option of changing this tentative color selection during the submittal process.

3. Color shall be uniform with no variation in shade, and panels of different color batches will not be acceptable.

2.09 BUILDING ACCESSORIES

A. Accessories

1. Accessories shall be manufacturer's standard unless otherwise indicated. Location of standard accessories shall be indicated on the erection drawings.

a. All miscellaneous trim and accessories shall match adjacent panels.

b. Metal curbs and pipe flashing shall be manufacturer standard except that interior faces of curbs must be fully enclosed also.

c. Gutters, downspouts, and trim pieces shall be provided by the manufacturer.

d. Trim materials shall be:

1) Outside corner trim shall be of the same material and finish as the exterior of wall panel.

2) Gutters, downspouts, eave trim and gable trim shall be prepainted galvanized steel.

3) Door side trim, drip gutters and base trim shall be prepainted Butler-Tone slate black galvanized steel.

B. Roof Fasteners

1. Self-tapping screws and other acceptable fasteners recommended by metal panel manufacturer. Provide corrosion-resistant fasteners with heads matching color of metal panels by means of factory-applied coating, with weathertight resilient washers.

C. Wall Fasteners

1. Base, Top, and Girt Connections and Panel Joint Clip Attachments: #14 self-drilling screws.

a. Install additional “Lockrivet” fasteners, if necessary due to wind load.

2. Panel-to-Panel Fasteners: Not required.

a. Connections: Hidden, eliminating exposed fasteners.

D. Sealants

1. Factory applied side lap sealant shall be a one part, non-skinning, non-drying, synthetic butyl elastomer.

2. Field applied hidden sealant at side laps, end laps, and flashing details shall be gun grade non-skinning butyl elastomer or polymeric non-skinning butyl tape to ensure weather tightness.

3. Exposed sealant shall be as one-part moisture curing, gun grade polyurethane as recommended in writing by the Manufacturer. Color shall match adjacent panels as approved by Engineer. Provide custom color as required.

E. Flashing

1. Preformed metal closures, trim pieces, flashings, sheets, clips, and associated appurtenances shall be as indicated or as otherwise required for weather tightness or completeness, and shall be of the same material, color, and finish as the adjacent panels, unless otherwise indicated.

a. Flashing and trim shall be minimum 20-gauge, formed, extruded metal fabricated with the same finish and color as the exterior face of the adjacent panels, unless otherwise indicated.

b. Work shall be coordinated as required to ensure proper flashing and seals to adjoining construction.

c. Flashing shall be provided for penetrations. Provide penetration enclosures, including hot pipe penetrations, to be weathertight. Coordinate locations of protruding pipes.

PART 3 -- EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in manufacturer's original, unopened packages, containers, or bundles with labels intact, which clearly identify contents.

1. Materials shall be delivered to Site in a dry and undamaged condition and unloaded per the manufacturer's instructions. The installer shall inspect materials for damage and stains upon arrival to the Site.

B. Store materials carefully in accordance with the manufacturer's written instructions, in an area that is protected from deleterious elements, and in a manner that will prevent damage to the products.

C. Verify that foundation, floor slab, mechanical and electrical utilities, and placed anchors are in correct position.

3.02 PRODUCT CONDITIONS

A. Comply with manufacturer's written instructions for environmental conditions before, during and after installation.

B. Protect surrounds Work from damage that may result from operations under this Section.

3.03 INSPECTION

A. The Contractor shall be totally responsible for the proper performance and completion of the Work under this Section.

B. The Contractor shall inspect materials for damage and shall confirm conformance with the specifications, erection drawings, and shop drawings prior to installation.

C. Systems and components shall be inspected before installation.

1. Damaged or defective items shall be rejected and marked as such and shall be removed from the Site.

2. Exposed surfaces that exhibit pitting, seam marks, roller marks, stains, discoloration, or other surface imperfections on the finished units shall be rejected.

D. The Contractor shall verify dimensions, tolerances, and method of attachment with adjacent Work.

1. Examine substrates, areas, and conditions where metal wall, roof and soffit panels, system support framing, and appurtenances will be installed for compliances with the requirements for installation, taking into account tolerances, and other conditions affecting performances of installed metal panels and appurtenances.

a. Provide inserts, backing blocking, anchoring devices, and reinforcements that must be built into other Work for the installation of metal wall, roof and soffit panels, system support framing, and appurtenances. Coordinate delivery with other Work to avoid delay.

b. Prior to installing the pre-engineered metal building the Contractor and the pre-engineered metal building installer shall verify final alignment of the foundation, floor slab, mechanical and electrical utilities to be in compliance with these specifications with the Contract Documents, with the erection drawings, and with the detailed design drawings.

2. Notify the Engineer in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until satisfactory conditions have been corrected in an acceptable manner.

3. Commencement of the installation by the Contractor shall indicate Contractor's acceptance of the substrate, areas, and conditions.

3.04 FABRICATION

A. The building shall be factory fabricated and erected to the manufacturer's written standards and shall be in accordance with AISC and MBMA standards.

B. The prefabricated building shall be completely fabricated and prepared for shipment including any necessary crating or bundling. All parts of the building shall be accurately made and true to dimension so that all parts will easily fit during installation.

3.05 PREPARATION

A. Sequence installation properly with the installation and protection of other Work, so that neither will be damaged by the installation of the other.

3.06 INSTALLATION

A. General

1. Installation shall comply with the requirements of the Contract Documents, with applicable references, with AISC, AISI MBMA, with the requirements of the CODE, and with manufacturer's written instructions. Where a conflict occurs among these requirements, the more stringent shall apply, as directed by the Engineer.

2. The Contractor shall provide corrosion resistant fasteners, anchors, and shims required for a complete installation, and shall be secure, plumb, level, straight, and true to line, allowing for required movement, including expansion and contraction.

3. The Contractor shall provide separation of dissimilar materials to ensure no galvanic action occurs.

a. Paint, bituminous coating, or sealant as recommended by the metal panel manufacturer shall separate dissimilar metals.

4. Horizontal lines shall be level, and vertical lines shall be plumb.

5. Manufacturer shall provide detailed instructions covering the tools, fasteners, sealants, gaskets, and procedures required to assure performance of the metal panel assembly.

6. Work shall be coordinated as required to ensure proper flashing and seals to adjoining construction.

7. Install panels in one continuous length, without horizontal seams, joints or laps.

B. Installation and Erection

1. Installation and erection of the building shall be in accordance with the manufacturer's standards and shall be workmanship of the highest quality. No field cutting of structural parts will be permitted. Field cutting and patching of panels and accessories will not be permitted unless authorized by the Engineer. Such field modifications, when authorized, shall be performed in a manner which will not impair the appearance, weather tightness, or structural quality of the material. Erection shall be accomplished in sufficient time to meet the schedule specified.

3.07 ROOF AND WALL PANELS

A. General: Apply panels and associated items for neat and weather tight enclosure. Avoid "panel creep" or application not true to line. Protect factory finishes from damage.

1. Flash and seal roof panels at eave and rake with rubber, neoprene or other closures to exclude weather.

B. Roof Panel Application

1. Panels shall be factory cut-to-length according to the erection drawings as furnished by the manufacturer.

2. Standing Seamed, Concealed-Fastener Insulated Metal Panels: Install metal panel system in accordance with manufacturer's written instructions, approved shop drawings, and project drawings. Install metal panels in orientation, sizes, and locations indicated. Anchor panels and other components securely in place. Provide for thermal and structural movement.

3. Attach panels to metal framing using clips, fasteners, and sealants recommended for application by metal panel manufacturer.

   a. Fasten metal panels to supports with fasteners at each location indicated on approved shop drawings, at spacing and with fasteners recommended by manufacturer.
   b. Cut panels in field where required using manufacturer's recommended methods.
   c. Provide weatherproof jacks for pipe and conduit penetrating metal panels.
   d. Dissimilar Materials: Where elements of metal panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by metal panel manufacturer.

4. Attach panel flashing trim pieces to supports using recommended fasteners and joint sealers.

   a. Seal panel side and perimeter joints using joint sealers indicated in manufacturer's instructions.

5. Fasteners shall be installed with proper tools, in a workmanlike manner according to the recommendations of the Manufacturer.

C. Wall Panel Application

1. Structural system shall be plumb before wall panels are attached.

2. Panels shall be aligned and attached in accordance with the erection drawings.

3. Sidelaps shall be at least one corrugation.

4. Panels shall be closed at base by metal closure.

3.08 CLEANING, FINISHING, AND PROTECTION

A. Adhesive papers used for masking which become firmly bonded when exposed to heat and/or light shall not be used.

1. Remove masking film and temporary labels as soon as possible after installation. Films and labels left in place after installation shall be the responsibility of the Contractor.

2. Residue shall not be left on any surfaces.

B. Upon completion of the installation of pre-engineered metal building and appurtenances shall be cleaned of dirt and other foreign matter to the satisfaction of the Engineer.

C. Cleaning shall be performed again immediately prior to acceptance of the Work, as determined by the Engineer.

1. Cleaning shall be performed in accordance with the manufacturer's written instructions.

2. Pre-engineered metal building shall be protected from damage from subsequent construction operations.

D. The Contractor shall make adjustments required until accepted.

E. The Contractor shall remove scratches and blemishes to the satisfaction of the Engineer.

F. Damaged or defective items shall be removed and replaced at the direction of the Engineer.

G. When pre-engineered metal building Work is completed, remove unused materials, containers, and equipment, and clean the Site of debris.

END OF SECTION

SECTION 13 38 00 – GEOMEMBRANE BAFFLES

PART 1 - GENERAL

1.1 SUMMARY

A. The Chlorine Contact Tank baffles shall be custom manufactured factory prefabricated hydraulic barrier curtains designed to improve flow characteristics in a new system.

1.2 SCOPE

A. Furnish and install reservoir baffles with appurtenances necessary to complete Work.

B. Each reservoir baffle shall include factory fabricated geomembrane panel(s) and related hardware required to complete the installation.

C. The manufacturer shall design and provide calculations demonstrating that the baffle walls can withstand momentum of the inlet flow. A flowrate of 2 MGD shall be used Reservoir baffles and anchoring system shall be capable of resisting seismically induced hydrodynamic forces and displacements as indicated.

1. The baffle system shall be detailed to allow controlled movement and flexibility, such that hydrodynamic impulsive (rigid body) forces are not developed. Rigid baffle walls systems are not permitted.

2. The baffle system shall be designed to resist the hydrodynamic convective (wave action) forces indicated below.

a. The baffle system shall be designed to resist a minimum uniform load on the baffle equal to 275 psf.

3. The baffle system shall be detailed such that failure of the baffle material, if subjected to forces exceeding the prescribed loads, will not result in the baffle materials being released into the Chlorine Contact Tank such that they come in contact with the existing 2 MG Reservoir.

D. Coordinate baffle anchor points and locations with the welded steel tank supplier. See Section 43 40 04 – Welded Steel Tanks

1.3 QUALIFICATIONS

A. Qualified manufacturers must have at least 20 years of experience in the fabrication of geomembrane products and must have manufactured a minimum of 2,000,000 square feet of baffles for reservoir applications.

B. The manufacturer shall utilize virgin quality elastomeric geomembrane materials and factory dielectric and thermal seaming processes throughout. The reservoir baffle support hardware shall be manufactured in prefabricated kits to minimize field cutting and drilling.

1.4 SUBMITTALS

A. All submittals shall be as specified in Section 01 33 00 – Submittal Procedures.

B. Product data.

C. Shop Drawings and Structural Design Calculations:

1. Shop drawings shall include dimensional drawings and complete details for anchoring the baffle system to the existing structure. All shop drawings shall be signed and stamped by a registered Civil or Structural Engineer in the State of Washington.

2. Structural calculations signed and stamped by a registered Civil or Structural Engineer in the State of Washington substantiating a complete design of the baffle system including, but not limited to, the following specific items:

a. Static loads due to the weight of the baffle system.

b. Hydrodynamic loads resulting from seismic-induced forces, as indicated above.

c. Complete anchorage calculations for anchorage of the baffle system to the existing structure.

PART 2 - MATERIALS

2.1 BAFFLE CURTAIN MATERIAL

A. Manufacturer:

1. Environetics, Inc., Lockport, IL, Phone: 815-838-8331. Model: Director III™ Clearwell Baffle System.

2. Or, equal.

B. Baffle Material:

1. The baffles shall be fabricated from NSF 61 approved polyester reinforced geomembrane material ENV-3004-12 (XR-3PW®), or equal.

2. Nylon reinforced materials will not be acceptable. The nylon reinforcing fabric will absorb water through the exposed scrim causing swelling and material delamination.

C. Baffle Anchoring Hems - The baffle manufacturer shall provide a 2” wide two-ply hem on all edges of the baffle curtains for anchoring purposes. The hem shall be wrapped over a 3/8” diameter stainless steel vinyl coated aircraft cable to prevent the hem section from pulling through the attachments.

D. Cutout and Re-entrant Corner Reinforcements – The baffle manufacturer shall provide reinforcement at all cutout and re-entrant corner locations to prevent tearing at the discontinuity.

E. Configuration:

1. Three baffles configured per 25D-101. Locate top of baffle at the elevation indicated on the Process drawings.

2.2 ANCHORING HARDWARE

A. Unless approved otherwise by the Structural Engineer of Record, the baffles shall be attached to the structure as required by the Manufacturer's structural engineering calculations and details, and shall meet or exceed the detailing indicated on the Process drawings.

B. All metal components and fasteners shall be Type 316 stainless steel.

C. All anchors shall be Type 316 stainless steel post-installed expansion anchors.

D. All hardware shall be supplied in ready to install kits, cut and pre-drilled to minimize field cutting and drilling of attachment hardware. Modifications of the hardware, if required, shall be made outside of the Clearwell.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation contractor shall install the reservoir baffles in the positions indicated on the Drawings.

B. The reservoir baffles shall be installed in accordance with the manufacturer's drawings, instructions and recommendations.

C. The manufacturer shall provide the services of a qualified on-site installation supervisor to ensure proper installation of the baffle system.

3.2 WARRANTY

A. Furnish a 10-year pro-rated warranty from the membrane material manufacturer.

END OF SECTION

SECTION 22 10 10 PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide plumbing piping and specialties, complete and operable, as indicated in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
09 96 00.10	High-Performance Coatings
23 07 00	HVAC Insulation
40 05 07	Pipe Supports
40 05 63	Ball Valves
43 30 52	Miscellaneous Valves

C. Reference Standards

American National Standards Institute (ANSI)	
NSF/ANSI 61	Drinking Water System Components – Health Effects
ANSI Z21.5a	Vented Decorative Gas Appliances
ANSI B31.8	Gas Transmission and Distribution Piping Systems
American Society of Mechanical Engineers (ASME)	
ASME B1.20.7	Hose Coupling Screw Threads (Inch)
ASME B16.3	Malleable Iron Threaded Fittings: Classes 150 and 300
ASME B16.9	Factory-Made Wrought Buttwelding Fittings
International Organization for Standardization (ISO)	
American Society of Sanitary Engineering (ASSE)	
ASSE 1001	Performance Requirements For Atmospheric Type Vacuum Breakers
American Society for Testing and Materials (ASTM)	
ASTM B88/B88M	Seamless Copper Water Tube
ASTM B32	Solder Metal
ASTM B813	Liquid and Paste Fluxes For Soldering of Copper and Copper Alloy Tube

ASTM A74	Cast Iron Soil Pipe And Fittings
ASTM D1785	Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, And 120
ASTM D2665	Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, And Vent Pipe And Fittings
ASTM D1784	Classification System And Basis For Specification For Rigid Poly(Vinyl Chloride) (PVC) Compounds And Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2672	Joints For IPS PVC Pipe Using Solvent Cement
ASTM A53	Pipe, Steel, Black And Hot-Dipped, Zinc-Coated, Welded And Seamless
ASTM D2513	Thermoplastic Gas Pressure Pipe, Tube, and Fittings
ASTM D2683	Socket Type Polyethylene Fittings for Outside Diameter – Controlled Polyethylene Pipe and Tubing
ASTM D3261	Butt Heat Fusion Polyethylene Plastic Fittings for Polyethylene Plastic Pipe and Tubing
American Water Works Association (AWWA)	
AWWA C708	Cold-Water Meters – Multijet Type
AWWA C651	Disinfecting Water Mains
AWWA C652	Disinfection of Water Storage Facilities
National Sanitation Foundation (NSF)	
NSF 372	Drinking Water System Components – Lead Content
NSF International STD 61	Drinking Water System Components – Health Effects
NSF International Std 14	Plastics Piping System Components And Related Materials
NSF Std 61	Drinking Water System Components – Health Effects
Safe Drinking Water Act (SDWA)	
United States Environmental Protection Agency (US EPA)	
Public Law (PL)	
PL 93-523	Safe Drinking Water Act
Cast Iron Soil Pipe Institute (CISPI)	
CISPI Standard 301	Hubless Cast Iron Soil Pipe And Fittings For Sanitary And Storm Drain, Waste, And Vent Piping Applications
Factory Mutual (FM)	
FM standard 1680	Approval Standard For Couplings Used in Hubless Cast Iron Systems for Drain, Waste or Vent, Sewer, Rainwater or Storm Drain Systems Above and Below Ground, Industrial/Commercial and Residential
Canadian Standards Association (CSA)	
CSA Standard B137.3	Rigid polyvinylchloride (PVC) pipe and fittings for pressure applications
Underwriters Laboratories of Canada (ULC)	

CAN/ULC-S102-2-M88	Standard Method of Test for Surface Burning Characteristics of Flooring, Floor Covering, and Miscellaneous Materials and Assemblies
International Organization for Standardization (ISO)	
ISO 9001	Quality management systems
Compressed Gas Association (CGA)	
CGA 9.1M	**Manually Operated Gas Valves for Appliances, Appliance Connector Valves and Hose End Valves**

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. General arrangement drawings of system components

2. Catalog cuts and other manufacturer information for products

C. Samples: electrically fused test joint for drainage and vent piping

1.4 WORKMANSHIP AND MATERIALS

A. Work shall be in strict accordance with the Washington State Plumbing Code and codes of the State of Washington, City of Carson, and any other authorities having jurisdiction.

B. The Contractor shall have required certifications and shall be thoroughly familiar with the local codes.

C. The Contractor shall obtain and pay for necessary permits.

D. Protection

1. Care shall be taken at all times to protect floors, stairways, and walls during the make-up and installation of piping and equipment.

2. The Contractor shall remove stains and repair damage before final acceptance of the Work.

E. Identifying Marks

1. If the Engineer finds materials that have identifying marks removed or lack such marks completely, such items will be rejected until the Contractor has furnished proof that said items conform to the Specifications.

2. Adequacy and extent of such proof will be determined by the Engineer.

PART 2 PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, and equipment shall be as recommended by the manufacturer for the intended usage.

B. Floor drains or floor sinks shall be provided for equipment drains.

C. No equipment drains shall discharge to floor slabs.

D. Any pipe, plumbing fitting or fixture, solder, or flux used in the installation or repair of any public water system or any plumbing in a facility providing water for human consumption, shall be “lead free” except when necessary for the repair of leaded joints of cast iron pipes.

1. Lead free products shall meet or exceed the requirements of the Safe Drinking Water Act (SDWA) - USEPA.

2. Lead free is defined as not more than 0.2 percent lead when used with respect to solder and flux; not more than 0.25 percent in the wetted surface material of pipes, pipe fittings, plumbing fittings and fixtures.

2.2 CPVC PIPING AND FITTINGS FOR POTABLE WATER PIPING (PV02)

A. CPVC pipes and fittings shall be suitable for potable water and meet the requirement of NSF 61

B. Potable water pipe material shall be Chlorinated polyvinyl chloride (CPVC) plastic pipe, schedule 40, meeting the requirement of standard ASTM D 2846 (or CSA B137.6) and ASTM F 441

C. CPVC pipe fittings shall meet the requirements of ASTM F 438

D. CPVC valves shall meet the requirements of NSF 61, ASME A112.4.14; ASME A112.18.1/CSA B125.1; ASTM F 1970; CSA B125.3

E. Joint surfaces shall be clean and free from moisture. Joints shall be made in accordance with the pipe manufacturer's installation instructions. Where such instructions require that a primer be used, the primer shall be applied to the joint surfaces and a solvent cement orange in color and conforming to ASTM F 493 shall be applied to the joint surfaces. Where such instructions allow for a one-step solvent cement, yellow in color and conforming to ASTM F 493, to be used, the joint surfaces shall not require application of a primer before the solvent cement is applied. The joint shall be made while the cement is wet and in accordance with ASTM D 2846 or ASTM F 493. Solvent cemented joints shall be permitted above or below ground.

2.3 PVC PIPING AND FITTINGS FOR PLANT DRAINS (PV08)

A. PVC Schedule 40 corrosion resistant sanitary pipe, IPS sizes 1/8-in through 24-in, shall be rated for temperatures up to and including 200 deg F, and Pressure rating (120 psi to 810 psi) depending on pipe schedule, pipe size, and temperature. Pipe shall be suitable for PVC plastic drain, waste, and vent (DWV) applications. Pipe material shall be generally resistant to most acids, bases, salts, aliphatic solutions, oxidants, and halogens. Chemical resistance data is available and should be referenced for proper material selection. Pipe exhibit excellent physical properties and flammability characteristics (independently tested flame and smoke characteristics-ULC). Typical applications include: chemical processing, plating, high purity applications, potable water systems, water and wastewater treatment, drainage, irrigation, agricultural, and other applications involving corrosive fluid transfer.

B. This specification outlines minimum manufacturing requirements for Polyvinyl Chloride (PVC) Schedule 40 iron pipe size (IPS) pressure pipe. This pipe is intended for use in applications where the fluid conveyed does not exceed 200 deg F. This pipe shall meet and or exceed the industry standards and requirements as set forth by the American Society for Testing and Materials (ASTM D1785 and ASTM D2665) and the National Sanitation Foundation (NSF International STD 61 and Std 14).

C. The material used in the manufacture of the pipe shall be domestically produced rigid polyvinyl chloride (PVC) compound, Type I Grade I, with a Cell Classification of 12454 as defined in ASTM D1784, trade name designation H707 PVC. This compound shall be white or gray in color as specified, and shall be approved by NSF International for use with potable water (NSF Std 61).

D. All sizes of PVC Schedule 40 pipe shall be manufactured in strict accordance to the requirements of ASTM D1785 for physical dimensions and tolerances. PVC Sch 40 pipe sizes 1-½-in through 24-in diameters shall also meet the requirements of ASTM D2665 Standard Specification for PVC plastic drain, waste and vent (DWV) pipe and shall be dual marked as such. Each production run of pipe manufactured in compliance to the standard, shall also meet or exceed the test requirements for materials, workmanship, burst pressure, flattening, and extrusion quality defined in ASTM D1785 and ASTM D2665 as applicable. All belled-end pipe shall have tapered sockets to create an interference-type fit, which meet or exceed the dimensional requirements and the minimum socket length for pressure-type sockets as defined in ASTM D2672. All PVC Schedule 40 pipe must also meet the requirements of NSF Standard 14 and CSA Standard B137.3 rigid PVC pipe for pressure applications, and shall bear the mark of these Listing agencies. This pipe shall have a flame spread rating of 0-25 when tested for surface burning characteristics in accordance with CAN/ULC-S102-2-M88 or equivalent.

E. Product marking shall meet the requirements of ASTM D1785 and ASTM D2665 as applicable and shall include: the manufacturer's name (or the manufacturer's trademark when privately labeled); the nominal pipe size; the material designation code; the pipe schedule and pressure rating in psi for water at 73 deg F; the ASTM designation ASTM D1785; the ASTM designation ASTM D2665 (when dual marked); the independent laboratory's seal of approval for potable water usage; and the date and time of manufacture.

F. All PVC Schedule 40 pipe shall be manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D1784. The pipe shall be manufactured in strict compliance to ASTM D1785 and ASTM D2665 (where applicable), consistently meeting and/or exceeding the Quality Assurance test requirements of these standards with regard to material, workmanship, burst pressure, flattening, and extrusion quality. The pipe shall be manufactured in the USA, using domestic materials, by an ISO 9001 certified manufacturer. Standard lengths of pipe sizes 6-in and larger shall be beveled each end by the pipe manufacturer. All pipe shall be stored indoors after production at the manufacturing site until shipped from factory. This pipe shall carry the National Sanitation Foundation (NSF) seal of approval for potable water applications.

2.4 INSULATION

A. Hot and cold water piping, valves, fittings, and exposed horizontal sanitary, storm, and vent piping shall be provided with 1-in thick insulation in accordance with the requirements of Section 23 07 00 – HVAC Insulation.

B. Coverings

1. Cover valves, flanges, fittings, and ends-of-insulation with a pre-molded high- and low-temperature PVC fitting cover, end cap, or similar pre-formed unit.

2. The pre-formed covers shall be sized to receive the same thickness of insulation as used in the adjacent piping and shall be in accordance with Section 23 07 00 – HVAC Insulation.

C. Exposed Piping

1. Exposed supply and drain piping shall be insulated and jacketed with ADA compliant safety cover under all lavatories in order to prevent burns and abrasions to handicapped persons.

2. Removable insulated covers shall be Plumberex Specialty Products Handy-Shield type, or equal.

2.5 HANGERS, SUPPORTS, AND MISCELLANEOUS METAL WORK

A. General

1. For utility piping such as cold water, hot water, compressed and vacuum air, and sanitary drain pipes located inside the building, the Contractor shall provide hangers and supports for vertical, axial, and seismic loads in accordance with the Code, and per Section 01 33 17 – Structural Design, Support and Anchorage.

2. No perforated strap hangers nor wire supports will be permitted.

3. The Contractor shall obtain the services of a registered mechanical or structural professional engineer for design of the supports, and the Shop Drawings showing installation shall be stamped by the registered engineer.

4. Pipe supports shall be as indicated in Section 40 05 07 – Pipe Supports.

B. Hangers supporting insulated piping shall be sized to fit the pipe plus the insulation.

C. Insulation at support points shall be provided with metal shields in order to prevent damage to the insulation.

D. Spacing

1. Pipe support spacing for steel and cast-iron pipe shall be as indicated in Section 40 05 07 – Pipe Supports.

2. Copper tube support spacing shall be not more than 6 ft between supports.

E. Rod sizes for pipe hangers shall be as recommended by the hanger manufacturer.

F. Pipe hangers used to support uninsulated copper tube shall be constructed of copper or copper plated.

G. Vertical piping shall be supported at the base with fittings made for this purpose or shall be supported from the nearest horizontal member or floor with a riser extension pipe clamp.

H. Inserts

1. Anchors that are installed into existing concrete shall be Grinnell Figure 117, Modern Figure 740, or equal, expansion case inserts.

2. Drill clean holes for the insertion of case and patch concrete around the hole, as required.

3. Continuous-slotted concrete inserts, if used, shall be Crawford Figure 148, Fee and Mason Figure 9000, or equal.

4. The Contractor shall provide secondary angle supports between main inserts in order to handle the loads which can be properly supported by such arrangement.

5. Concrete inserts shall be as indicated in Section 40 05 07 – Pipe Supports.

6. Inserts shall be galvanized.

2.6 PIPE SLEEVES

A. Sleeves shall be constructed from Schedule 40 galvanized steel pipe, one size larger than the pipe passing through, or where pipe is insulated, one size larger than the pipe plus insulation.

B. At exposed wall or ceiling surfaces, install a suitable chromium plated brass wall plate approved by the Engineer.

C. At exterior wall pipe penetrations, the space between the sleeve and pipe shall be made watertight with a modular or link rubber seal. The link seal shall be applied at both ends of the sleeve.

D. To prevent accidental liquid spills from passing to a lower level, provide the following:

1. For sleeves: Extend sleeve 1-in above finished floor and provide sealant for watertight joint.

2. For blocked out floor openings: Provide 1 1/2-in angle set in silicone adhesive around opening.

3. For drilled penetrations: Provide 1 1/2-in angle ring or square set in silicone adhesive around penetration.

E. Pipe penetration sleeve materials shall comply with all fire stopping requirements for each penetration. Caulk opening at fire-rated walls minimum ½-in depth with an approved fire barrier caulk.

2.7 VALVES

A. Water shutoff valves shall be of the ball valve type, including on fixture supply piping.

B. Hose Valves

1. Interior hose valves shall be provided as indicated.

2. The hose nipple shall be a female iron pipe thread inlet with hose thread outlet.

3. Hose bibbs shall be ¾-in 1-in size.

C. Ball valves shall be in accordance with the requirements of Section 40 05 63 - Ball Valves.

D. Ball Shut-Off Valves

1. Provide ball shut-off valves on cold water piping at entrances to pipe chases and other inaccessible areas and wherever indicated or required to obtain the maximum efficiency for shut-off control on the water system.

2. Ball shut-off valves shall be placed on hot and cold water connections to equipment and fixtures.

3. Show the locations of shut-off valves on the Shop Drawings.

2.8 FLOOR DRAINS IN CONCRETE FLOORS

A. Floor drains in concrete floors shall be constructed of cast iron, in the sizes indicated, and provided with sediment buckets.

B. Each floor drain located on an upper floor shall have a clamping collar, with 4 lbs sheet lead flashing 12-in minimum all around.

C. Where lead flashing does not comply with the Code, use epoxy waterproofing material, and submit a Shop Drawing for review.

D. Manufacturers, or Equal

1. Josam Mfg. Co., Series 32100-AE-81

2. Jay R. Smith Mfg. Co., Fig. 2350

3. Zurn Industries, Inc., Series Z-520-Y

2.9 FLOOR DRAINS IN CHEMICAL AREAS

A. Floor drains in chemical handling areas subject to corrosive liquids shall be made of Acid Resisting Epoxy Coated Cast Iron iron body with NO-HUB mechanical joints, heavy-duty cast iron deep flange slotted grate, and Sediment Bucket

B. Thermoplastic floor drains are not acceptable.

C. Manufacturer, or Equal

1. Zurn Z520 for slab-on-grade drains**,** or for drains on upper floors

2. Josam Mfg. Co.,

3. Jay R. Smith Mfg. Co.

2.10 ELECTRIC ACTUATED TYPE TRAP PRIMER

A. Where required by the Code, floor drains and floor sinks connected to the sanitary sewer shall be furnished with trap primers connected to the water supply.

B. Run ½-in copper tubes from the primers to the traps.

C. Trap primers shall be surface mounted in accessible locations.

D. Factory programmed, 4 to 30 port manifold, Electronic Trap Primer providing automatic trap priming.

E. Unit will supply a minimum of 2 oz of potable water at 20 PSIG at a preset factory setting of 6 seconds every 24 hours. The entire unit is pre-assembled in a NEMA 1 galvanized steel surface mounted housing and cover.

F. ¾ FNPT inlet connection, brass ball-type stop valve, 120 VAC solenoid valve, brass atmospheric vacuum breaker, 5/8 or 1/2 outlet compression fittings.

G. Anti-Siphon atmospheric vacuum breaker meets Los Angeles code, IAPMO, New York Board of Standards, ASSE 1001 and CSA.

H. Electrical 2 amp Circuit Breaker, Manual Over Ride Switch/Test Button, Timer, 120 VAC Solenoid Valve marked as UL listed. 2 wire plus ground, hold current 0.13 Amps, in rush 0.28 amps.

I. Manufacturers, or Equal

1. Precision Plumbing Products, Model PTS

2. Zurn Industries, Inc.

2.11 CLEANOUTS

A. Cleanouts shall be heavy plugs with tapered shoulders against caulked lead or heavy brass plugs.

B. Where underground or concealed, cleanouts shall be brought to floor level and to accessible locations with access covers and frames.

C. Cleanouts shall be installed such that they do not create a tripping hazards for people.

D. Manufacturers, or Equal

Service	**Josam Series**	**J.R. Smith No.**	**Zurn No.**
Exposed Locations	58500-20	4405	Z-1440-A
Underground (finished floors)	56010/30	4143	ZN-1400-2
Walls, Concealed	58790-20	4535	ZN-1445-1-A
Traffic Areas	56070	4240	Z-1420-27

E. Cleanouts shall have a minimum diameter of 3-in

F. Stack cleanouts shall be installed at the base of each stack.

G. Cleanouts shall be fabricated from galvanized cast iron with ABS plastic cleanout plugs.

2.12 HOSE BIBBS AND HYDRANTS

A. Hose bibbs and hydrants in exposed locations subject to freezing shall be the non-freeze type.

B. Hose bibbs connected to a non-potable water supply shall be provided with plastic or stainless steel warning signs reading "DO NOT DRINK" in clearly legible letters, permanently attached at the hose bibb.

C. Hose bibbs shall be provided with vacuum breakers as furnished by Crane Co., American Standard, or equal.

D. Manufacturers or Equal

Drawing Callout	**Fixture Type**	**Description**
HB-1	Indoor Hose Bibb	Exposed, anti-siphon, wall faucet for indoor installation, complete with Z1399-BFP external backflow preventer, all bronze interior components, vandal-resistant operating stem, rough bronze exterior and ¾ male hose connection (Conform to ASME B1.20.7). Zurn Industries, Inc., Model Z1341-BFP

HB-2	Non-Freeze Hydrant, Wall-Type	Heavy duty bronze hydrant with nickel-bronze face, hinged cover, recessed box, and key. Length to suit wall. Jay R. Smith Mfg. Co., Fig. 5509 Josam Mfg. Co., Zurn Industries, Inc.,

2.13 WALL-MOUNTED HOSE RACKS

A. The Contractor shall provide wall-mounted hose racks at the indicated locations.

B. Racks shall be of welded steel construction, minimum 8 gauge sheet steel, hot-dip galvanized after fabrication, and shall have a capacity to hold 100 ft of the indicated hose.

C. Racks located in the open shall be supported from two 2-in by 2-in by ¼-in galvanized steel angle posts set in a concrete base or as indicated.

2.14 HOSES AND NOZZLES

A. The Contractor shall furnish the following lengths of hose:

1. 6 lengths of 75 ft long, ¾-in hose.

a. Each length of hose shall be provided with male and female connectors and a nozzle.

b. Hoses shall be fabricated from seamless extruded rubber designed for a working pressure of at least 300 psig and shall be suitable for industrial applications.

c. Hoses shall be oil resistant reinforced to provide kink resistance.

d. Hoses shall be provided with brass threaded fittings, for hose bib and nozzle connection.

e. Temperature range is -20 deg F to 180 deg F.

2. Hoses Manufacturers, or Equal

a. Flexicraft, Model RM1

B. Nozzles:

1. Nozzles shall be capable of complete shut-off and shall produce a solid straight stream and up to a 90 deg conical fog.

2. Nozzle material shall be polished brass.

3. Nozzles shall be provided with rubber bumpers.

2.15 BACKFLOW PREVENTER

A. Provide reduced pressure backflow prevention units where indicated.

B. The valve shall be designed to be installed either vertically or horizontally.

C. The units shall be of bronze body construction, with celcon check seats and stainless steel relief valve seats, shafts, and bolts.

D. The units shall be provided with tight-seating check valve and relief assemblies, and bronze bodies with non-rising stem ball valve test cocks.

E. The units shall be Watts Regulator Co., No. LF909 Series, or Engineer approved equal.

F. Installation shall meet local code requirements.

G. Nozzle Manufacturers, or Equal

1. W.D. Allen Mfg. Co.

2. Fire-End and Croker Corp.

3. Halprin Supply Co.

4. Western Fire Equipment Co.

2.16 PAINTING

A. Ferrous metal, except finished, galvanized, and machined surfaces, shall have surfaces prepared and primed in the shop in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

B. Prime colors shall be compatible with finish coats that are applied in the field.

C. Self-contained units such as wall-mounted hose racks shall be supplied with factory-applied finish coats of baked enamel.

D. Field painting shall comply with the requirements of Section 09 96 00.10 – High-Performance Coatings.

PART 3 EXECUTION

3.1 PREPARATION

A. The Contractor shall coordinate the roughing-in process with provisions for wall and floor sleeves, pipe inserts, and cutting of roof and floor penetrations, such that drain lines will have the required invert elevations and slopes.

B. Cleanouts shall be installed such that they do not create a tripping hazard for people.

3.2 OPENINGS

A. New Construction

1. The Contractor shall provide necessary openings in walls, floors, and roofs for the passage of piping and plumbing equipment within and into the building.

2. Openings shall be as indicated or as required to provide passage for the plumbing Work.

3.3 INSTALLATION AND APPLICATION

A. The Contractor shall provide plumbing specialties in accordance with manufacturer's printed instructions.

B. Pipe shall be arranged in a neat and orderly manner to occupy the minimum amount of space and so that the pipe will not obstruct passageways and movement of building occupants or interfere with normal operation and maintenance of any equipment.

C. Pipe shall be carefully placed and properly sloped and shall be neatly and firmly supported by hangers or supports.

D. Piping in buildings shall be as close to the ceilings or walls as possible unless indicated otherwise.

E. Joints

1. Screwed joints shall be made with joint compound and be tight and leak-proof.

2. A sufficient number of brass-to-ferrous metal seat unions shall be placed in lines such that any pipe, valve, or piece of equipment may be easily disconnected.

F. Drainage and Sanitary Lines

1. Drainage and sanitary lines shall be properly run, trapped, and vented in order to conform to Code requirements.

2. Changes in direction shall be made with "Y" branch fittings and shall be of the same size as the pipe.

3. Changes in pipe size shall be made with reducing fittings.

4. The minimum depth of cover shall be 3 ft.

G. Horizontal soil, drain, and waste pipes shall be provided with a slope of at least ¼-in per foot, unless indicated otherwise.

H. Floor drains and cleanouts shall be installed such that the tops of the drains are flush with the finished floor.

I. Plug each natural gas outlet, including valves, with a threaded plug or cap immediately after installation, and retain the plugs until continuing piping or equipment connections are completed.

J. Joints in PE pipe shall be installed such that the longitudinal pull out resistance of each joint is at least equal to the tensile strength of the pipe.

3.4 EQUIPMENT DAMAGE AND REMOVAL

A. The Contractor's operations shall be carried out in such a manner as to guard against damage to those portions of the structure and equipment that are to remain in the finished Work.

B. Any damage caused by the Contractor or Subcontractor through their operations shall be repaired to the satisfaction of the Engineer.

3.5 TESTING

A. The Contractor shall perform such tests as are required by local ordinances and Codes in the presence of a local governing authority inspector to show that piping is tight, leak-free, and otherwise satisfactory, and shall also perform such tests as the Engineer may direct to ensure that fixtures and equipment operate properly.

B. The Contractor shall pay the costs to perform such tests and the costs of making changes or repairs until the Work is acceptable to the governing authorities.

C. Gas Piping Testing and Purging

1. Before the gas piping system is accepted, a test for tightness shall be performed and witnessed by the Engineer.

2. The system shall be subjected to a test pressure of at least 1.5 times the maximum operating pressure, but never less than 3 psig.

3. Air or an inert gas such as carbon dioxide, or nitrogen, shall be used as the pressurizing medium.

4. Under no circumstances shall oxygen or natural gas be used to test for tightness or to locate leaks.

5. The system shall hold pressure after disconnecting the pressure source for a period of at least 30 minutes without showing any drop in pressure after the test gas in the pipe has been given time to come to equilibrium at the ambient temperature.

6. Leaks shall be located by approved leak detectors, or by a soap and water solution, while the system is under pressure.

7. Purging

a. After pressure testing, piping shall be fully purged with an inert gas inserted from the location most distant from the point of entry of the natural gas.

b. Each major branch line shall be similarly purged from its far end.

c. Purging shall be performed only by personnel experienced in this particular operation.

8. Repair or replace defective piping, and retest.

D. Potable Water and Drainage Piping Pressure Testing

1. Demonstrate to an Owner witness that the piping passes the following pressure tests before it is insulated or covered by walls or ceilings. Test piping after all fittings and valves for that portion of the piping have been installed.

2. All pressure testing shall be witnessed and documented with results approved and signed off by an Owner representative.

3. Repair leaks discovered during pressure testing. Retest failed sections of piping to demonstrate satisfactory results.

4. Potable Water Testing: Upon completion of a section or of the entire hot and cold water supply system, it shall be tested and proved tight under a water pressure not less than one and half time of the working pressure under which it is to be used, but not less than 125 psi. The water used for tests shall be obtained from a potable source of sup- ply. The piping shall withstand the test without leaking for a period of not less than 15 minutes.

5. Drainage Water Testing: The drainage, and venting systems shall be tested with water. The water test shall be applied to the drainage and vent systems either in its entirety or in sections. Where the test is applied to the entire system, openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. Where the system is tested in sections, each opening shall be tightly plugged, except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10 ft head of water. In testing successive sections, not less than the upper 10 ft of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 ft of the system) shall have been submitted to a test of less than a 10 ft head of water. The water shall be kept in the system, or in the portion under test, for not less than 15 minutes before inspection starts. The system shall then be tight at all points.

3.6 DISINFECTION

A. The line shall then be filled with water and maintained under not less than 10 psig pressure, for not less than 48 hours, during which period each valve on the line shall be opened and closed several times, after which it shall be flushed clean and then tested by the Owner.

B. After potable water supply lines are successfully pressure tested, they shall be disinfected by introducing an HTH solution, liquid chlorine, or chlorine solution of sufficient strength.

C. Potable water systems shall be purged of deleterious matter and disinfected prior to utilization. The method to be followed shall be that prescribed by the health authority or water purveyor having jurisdiction or, in the absence of a prescribed method, the procedure described in either AWWA C651 or AWWA C652, or as described in this section.

1. The pipe system shall be flushed with clean, potable water until dirty water does not appear at the points of outlet.

2. The system or part thereof shall be filled with a water/chlorine solution containing not less than 50 parts per million (0.0080 oz./gal) of chlorine, and the system or part thereof shall be valved off and allowed to stand for 24 hours; or the system or part thereof shall be filled with a water/chlorine solution containing not less than 200 parts per million (0.032 oz./gal) of chlorine and allowed to stand for 3 hours.

3. Following the required standing time, the system shall be flushed with clean potable water until the chlorine is purged from the system.

4. The procedure shall be repeated where shown by a bacteriological examination that contamination remains present in the system.

D. This procedure shall be repeated as often as necessary until the line is pronounced safe for use by the Owner.

E. No cross-connection between the water main and any pipe not yet disinfected will be permitted.

END OF SECTION

SECTION 22 30 00 PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide plumbing fixtures and plumbing equipment as indicated, complete with water, gas and electric connections and hook-ups, for a complete and operable installation as indicated in accordance with the requirements of the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

C. Shop Drawings

1. Certified pump curves for each pump

D. O&M Data

1. Submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.3 WARRANTY

A. Water heaters shall have 5 year warranty

1.4 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

A. Reference Standards

American National Standards Institute (ANSI)	
ANSI Z21.10.3	(2019) Gas-Fired Water Heaters Vol.III, Storage Water Heaters with Input Ratings Above 75,000 Btu/hr, Circulating and Instantaneous
American Petroleum Institute (API)	
American Society of Mechanical Engineers (ASME)	
API-ASME Code	Unfired Pressure Vessels for Petroleum Liquids and Gases
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	

ASHRAE 93-1986	Methods of Testing to Determine the Thermal Performance of Solar Collectors
Canadian Standards Association (CSA)	
International Electrical Commission (IEC)	
International Energy Conservation Code (IECC)	
IECC 2006	International Energy Conservation Code 2006
Solar Rating and Certification Corporation (SRCC)	
SRCC OG-300	(2015) Solar Thermal System Certification Program
Underwriters Laboratories (UL)	
UL 508	(2018; Reprint Jul 2021) UL Standard for Safety Industrial Control Equipment

PART 2 PRODUCTS

2.1 GENERAL

A. Plumbing piping, fixtures, specialties, equipment, and appurtenances shall be new, first-quality products manufactured for the intended usage.

B. Materials, capacities, features, finishes, and manufacturers shall be as indicated and shall be compatible with elements of the Work to which they relate or connect.

C. Any pipe, plumbing fitting or fixture, solder, or flux used in the installation or repair of any public water system or any plumbing in a facility providing water for human consumption, shall be “lead free” except when necessary for the repair of leaded joints of cast iron pipes.

1. Lead free is defined as not more than 0.2 percent lead when used with respect to solder and flux, not more than 0.25 percent in the wetted surface material of pipes, pipe fittings, plumbing fittings and fixtures.

2.2 INSTANTANEOUS ELECTRIC WATER HEATER FOR RESTROOM (WH-01)

A. Provide an electric instantaneous water heater of the size and capacity as indicated.

B. Water heater shall be point of use model designed for low demand.

C. Water heater shall meet the requirements of UBC, CEC, CSA, ASHRAE/IES 90.1 and national codes

D. Water heater shall be provided with side mounted plumbing and electrical connections with optional top mounted water connections for field conversion. Design shall be for installation in tight spaces.

E. Provide superior corrosion resistance

F. Water heater shall have following features:

1. PEX cross linked polymer dip tube

2. Tamper resistant, solid brass, enhanced flow, ball type drain valve

3. Standard female hose fitting that allows for fast and easy draining during maintenance

4. Certified for 300 psi test pressure and 150 psi working pressure.

5. ½" NPT water connections

G. Control

1. The unit shall be microprocessor controlled.

2. When a hot water tap is opened, the cold water entering the heater shall pass over a thermostat, turning on an electrical heat coil that shall heat the water up to 125 deg F.

3. As the mixture of hot and cold water is adjusted, other converting thermostats shall recalculate the flow of energy sequentially adding or subtracting energy to maintain a constant temperature.

4. When the hot water is turned off, the flow of energy shall turn off as well.

H. The heater shall be UL-listed and shall be guaranteed for life against leakage and rupture.

I. Manufacturers, or Equal

1. AO Smith Model EPU-2.5

2.3 INSTANTANEOUS ELECTRIC WATER HEATER FOR EMERGENCY SHOWERS AND EYE WASH (WH-02)

A. Provide an electric instantaneous water heater of the size and capacity as indicated.

B. The heater shall minimize temperature fluctuation from normal flows as high as 20 gpm with instantaneous drops to as low as 2.5 gpm with minimal overshoot to aid in the transition between emergency shower use to the use of an eyewash station.

C. The hot water shall ensure temperatures never exceed "tepid" ANSI standards and shall operate without the necessity of tempering valves and scald guards.

D. Control

1. The unit shall be microprocessor controlled.

2. When an emergency shower or eye wash is activated, the cold water entering the heater shall pass over a thermostat, turning on an electrical heat coil that shall heat the water up to 125 deg F.

3. As the mixture of hot and cold water is adjusted, other converting thermostats shall recalculate the flow of energy sequentially adding or subtracting energy to maintain a constant temperature.

4. When the hot water is turned off, the flow of energy shall turn off as well.

E. The heater shall be UL-listed and shall be guaranteed for life against leakage and rupture.

F. Instantaneous electric waters shall be provided with the following features:

1. Precise digital temperature control to ensure safe operation within the ANSI standards
2. Internal safety features
3. Anti-scald protection
4. Thermal overheat protection
5. Flow activation
6. Internal fusing
7. Incoloy heating elements
8. Bimetal overheat protection
9. NEMA-4 enclosure
10. External emergency stop button
11. Solid-state relays
12. Internal finger-safe fusing
13. Dual PID control with digital display of set-point and actual temperature
14. Copper/brass construction for increased heat exchanger life

G. Instantaneous electric water heaters shall meet the following requirements:

Water Heater Identification	WH-02
Exchanger material	Copper/brass
Box	NEMA 4 rated enclosure, 14 guage mild steel and powder coated
Power input, KW	63
Minimum Water Flow and Temperature rise	20 gpm, 20 ΔT deg F
Operating range, psi	5-100
Max AMPS	76
Codes compliance	ANSI Z358.1-2004, IECC 2006
Test procedure	ANSI Z21.10.3

Voltage / phase / Hertz	480 / 3 / 60

H. Manufacturers or Equal

1. KELTECH INCORPORATED, Model SNA 63KW

2.4 EXPANSION/COMPRESSION TANKS AND ACCESSORIES

A. General

1. Provide expansion/compression tanks and accessories as indicated.

2. The tank shall have 304L stainless steel waterway

3. The tank shall be hydrostatically tested for a working pressure of 125 psig and shall be ASME rated.

4. The tank shall be rated for a maximum intermittent temperature of 140F.

B. Manufacturers or Equal

1. AMTROL Therm-X-Trol ST-1

PART 3 EXECUTION

3.1 WATER HEATER INSTALLATION

A. The Contractor shall install the water heaters in accordance with the manufacturer's printed instructions.

B. The Work shall be coordinated with plumbing piping and related electrical Work.

C. The Contractor shall provide steel pipe supports for tanks, independent of building structural framing members.

D. Tanks shall be cleaned and flushed prior to delivery at Project Site.

E. Equipment openings shall be sealed until piping connections are made.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. The Contractor shall provide plumbing fixtures, complete and operable, as indicated in accordance with the Contract Documents.

1.2 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Show material type, material thickness, sinks, counters, splashes, drawers, shelves, legs, frame, supports, and anchors or fasteners for the counter sink unit.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
07 92 13	Elastomeric Joint Sealants

C. Reference Standards

American Bureau of Shipping (ABS)	
Americans with Disabilities Act (ADA)	
American National Standards Institute (ANSI)	
NSF/ANSI 61	(2020) Drinking Water System Components – Health Effects
ANSI A112.6.1	Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
ANSI A112.18.1	Plumbing Fixture Fittings
ANSI A112.18.1M	Plumbing Fixture Fittings
ANSI A112.19.1	Enameled Cast Iron Plumbing Fixtures
ANSI A112.19.2	(1973) Vitreous China Plumbing Fixtures
ANSI A112.19.4	(1994) Porcelain Enameled Formed Steel Plumbing Fixtures (with Supplement and Errata)
ANSI A112.19.5	Trim for Water Closet Bowls, Tanks and Urinals
ANSI A117.1	(2009) Accessible and Usable Buildings and Facilities
ANSI Z124.2	(1995) Plastic Shower Units

ANSI Z358.1	(2014) American National Standard for Emergency Eyewash and Shower Equipment
American Society of Mechanical Engineers (ASME)	
ASME A112.19.2	(2018) Ceramic Plumbing Fixtures
ASME A112.6.1M	(1997) Floor-Affixed Supports for the Off-the-Floor Plumbing Fixtures for Public Use
ASME A112.6.2	Floor Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use
American Society of Sanitary Engineering (ASSE)	
ASSE 1070	(2015) Performance Requirements for Pressurized Flushing Devices for Plumbing Fixtures
ASSE 1071	(2012) Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
International Building Code (IBC)	
International Code Council (ICC)	
NSF International (NSF)	

PART 2 PRODUCTS

2.1 GENERAL

A. Reference Standards: Products in this section shall be built, tested, and installed in compliance with the following quality assurance standards; latest editions, unless noted otherwise.

International Plumbing Code with local amendments.	
NSF/ANSI-61	G Drinking Water System Components - Health Effects
ANSI A112.6.1	Supports for Off-the-Floor Plumbing Fixtures for Public Use
ANSI A112.18.1	Finished and Rough Brass Plumbing Fixture Fittings
ANSI A112.19.1	Enameled Cast Iron Plumbing Fixtures
ANSI A112.19.2	Vitreous China Plumbing Fixtures
ANSI A112.19.4	Porcelain Enameled Formed Steel Plumbing Fixtures
ANSI A112.19.5	Trim for Water-Closet Bowls, Tanks, and Urinals
ANSI Z124.2	Gel-Coated Glass-Fiber Reinforced Polyester Resin Shower Receptor and Shower Stall Units
ANSI Z358.1	Emergency Eye Wash and Shower Equipment
ASSE 1071	Performance Requirements for Temperature Actuated Mixing Valves for Plumbed Emergency Equipment
ARI 1010	Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers

B. Plumbing piping, fixtures, specialties, and equipment shall be:

1. Of the latest design.

2. All brass must be of the best quality. Lightweight goods will not be accepted.

3. Manufactured for the intended usage.

4. Compatible with elements of related or connected Work.

C. Design Features

1. Plumbing fixtures shall be provided without flaws, and with a white finish unless otherwise indicated.

2. Exposed brass, faucets, valves, wastes, traps, piping, and escutcheons shall be chrome plated. Faucets shall be free of tool marks or other flaws.

3. "P" traps on lavatories and sinks shall be cast brass with cleanouts.

4. Each fixture shall be provided with individual stops and shall be anchored firmly to the building wall or floor.

5. Softeners, water heaters, and lab equipment shall be provided with drains and isolating valves on each side.

6. For the purpose of establishing type and class of fixtures and faucets required, the following manufactures and models are indicated: Fixture manufacturers and model of equal features and quality may be submitted for approval.

7. Refer to Architectural Drawings for mounting height and exact location of all plumbing fixtures. Handicapped fixtures shall be installed to meet the latest ADA requirements.

D. Water closets, valves, fixtures, and hardware shall be approved by local governing authorities as low-flow items.

E. Floor-mounted and tank-type water closets indicated (by "HC") for handicapped persons or located within a toilet stall indicated for handicapped persons shall conform to ADA requirements.

F. Any pipe, plumbing fitting or fixture, solder, or flux used in the installation or repair of any public water system or any plumbing in a facility providing water for human consumption, shall be “lead free” except when necessary for the repair of leaded joints of cast iron pipes.

1. Lead free means not more than 0.2 percent lead when used with respect to solder and flux, not more than 8 percent when used with respect to pipes and pipe fittings, and not more than 4 percent with respect to plumbing fixtures.

G. Pre-wrapped Insulation

1. Insulate exposed lavatories drain piping, hot/cold stops and supplies in accordance with the requirements of ADA and the International Building Code (IBC).

2. The pre-wrapped insulation shall be easily removable, bacteria resistant, molded to piping and fixture configurations, closed cell vinyl assembles.

3. Fasteners shall be corrosion-resistant and reusable.

4. Pre-wrapped insulation shall be Lav Guard as manufactured by Truebro, Inc., Pro-Wrap as manufactured by McGuire Manufacturing Co., or equal.

2.2 FIXTURE SCHEDULE

Drawing Callout	Fixture Type	Description
WC-1	Water Closet (ADA complaint floor-mounted)	Water closet, with elongated floor mounted siphon jet bowl; designed to flush at both 1.28 gpf, white solid plastic open front seat; self-sustaining hinges; and manual flush valve and escutcheons (with 1-in water supply connection) 16 5/8-in rim height, 12-in rough-in. Accepted manufacture: Kohler K-96057, Highcliff Ultra
LAV-1	Lavatory (ADA compliant wall-hung)	Lavatory basin, vitreous china, wall-mount, with overflow, drilled for concealed, single-hole, size 20-in x 27-in, complete with wall carrier; chrome-plated combination supply with angle stops and pop-up fitting with aerator; lsensor faucet with thermostatic mixing valve, and a 1 ¼-in, chrome-plated "P" trap with chrome-plated escutcheon. Code Standards: ASME A112.19.2/CSA B45.1 ADA ICC/ANSI A117.1 Acceptable manufacturer: Kohler, Model K-12638, Greenwich
ESEW-1 and 2	Emergency Shower (with eye-face wash and independent operated valves)	The emergency drench showers, not subject to freezing, with shower head, self-closing manual valve, handle, eyewash with stainless steel bowl and galvanized drain, emergency alarm light, buzzer, and flow switch with two dry contacts, and 1 ¼-in supply. HAWS Model No. 8317, Bradley Corp. Model S19-310 with ASSE 1071 certified Thermostatic mixing valve, or equal. Emergency alarm system shall be HAWS Model 9001, or equal, and shall include a flow switch activated intermittent audible alarm rated at 90db @ 10 ft, and 100 W green flashing area light.

2.3 MANUAL FLUSH VALVE FOR WATER CLOSET

A. Manual Flush Valve (1.28 gpf)

1. Exposed Manual Flush Valve for Water Closets- Exposed, quiet diaphragm-type, chrome plated, flushometer valve with a polished exterior. Complete with a chloramine resistant, dual seal diaphragm with a clog resistant by-pass.

2. The valve is complete with high back pressure vacuum breaker, one piece hex coupling nut, adjustable tailpiece, spud coupling and flange for top spud connection. Control stop has internal siphon-guard protection and vandal resistant stop cap. Internal seals are made of chloramine resistant materials.

3. Valve handle shall be ADA compliant with a non-hold open and no leak handle feature.

4. Valve shall be provided with 1-in inlet, 1 ½-in outlet and 1.28 gallon per flush.

5. Acceptable manufacturers:

   a. Zurn, Model Z6000AV-WS1

   b. Delany

   c. Sloan

B. Wall Carrier

1. Fully compatible with water closet installation, adjustable, high extension (barrier free), cast iron frame with integral drain hub and vent, lugs for floor and wall attachment and threaded fixture studs.

2. The carrier shall conform to ASME A112.6.1M or ASME A112.6.2

3. Acceptable manufacturers:

   a. J.R. Smith

   b. Josam

   c. Zurn

C. Seat

1. Open front, elongated, heavy duty injection molded white plastic, open front, extended back, hinged shall be self-sustaining with stainless steel fasteners, molded-in bumpers, without cover.

2. Seat shall comply with ANSI Z124.5 Toilet (Water Closet) Seats as a class Commercial Heavy Duty.

3. Acceptable manufacturers:

   a. Bemis 1955SSCT

   b. Church

   c. Centoco

2.4 WALL MOUNTED LAVATORIES

A. General

1. Vitreous China Wall Hung Lavatory: ASME A112.19.2; vitreous china wall mount lavatory with overflow, with 4-in high back, 21-in x 18-in with drillings on 4-in centers.

2. Complete with concealed arm carrier and wall hanger.

3. Acceptable manufacturers:

   a. Kohler, Model K-2032, Greenwich.

   b. American Standard

   c. Crane

B. Sensor Activated Faucet (1.0 gpf)

1. Chrome plated cast brass sensor faucet with motorized actuator, an integral infrared convergence-type proximity sensor with thirty second time out feature. Faucet shall be ADA compliant.

2. Furnish with 0.5 gpm aerator (complying with ANSI A112.18.1M Standard for flow).

3. Furnish with 4-in centers cover plate.

4. Complete with hardwire 7.6 VDC power converter. Each power converter can accommodate up to eight valves., Zurn P6000-HW6 or equal.

   a. Acceptable manufacturers:

   b. Zurn, Model Z6913-F-CP4-XL

   c. Meon

   d. Sloan

C. ACCESSORIES

1. Chrome plated 17-gage brass P-trap with clean-out plug and arm with escutcheon.

2. Chrome plated rigid supplies to fixtures with supply stops, reducers, and escutcheons.

3. Offset waste with perforated open strainer.

4. Exposed piping, waste and supply, shall be insulated and offset to meet ADA compliance.

D. Thermostatic mixing valve shall conform to ASSE 1070 and designed to be installed at the point of use. Zurn Model ZW1070XL or equal.

PART 3 EXECUTION

3.1 INSTALLATION

A. Each fixture shall be installed with a trap that is easily removable for servicing and cleaning and vented in accordance with the applicable plumbing code.

B. The Contractor shall provide chrome-plated rigid or flexible supplies to fixtures with angle stops, reducers, and escutcheons.

C. Components shall be installed level and plumb, and supplies and wastes shall be centered on or between the wall tiles.

D. Attachment

1. Fixtures shall be installed and secured in place with wall carriers and bolts.

2. Water closets shall be solidly attached to a floor or wall carrier with lag screws.

3. Lead flashing shall not be used to hold fixtures in place.

E. Sealant

1. Fixtures shall be sealed to wall and floor surfaces with sealant in accordance with the requirements of Section 07 92 13 – Elastomeric Joint Sealants.

2. Sealant color shall match the fixture.

F. Fixtures shall be mounted to the following heights above finished floor:

Lavatory		
Handicapped	34-in, max 29-in, min	to top of basin rim clearance under or pullman option
Water Closet Flush Valves		
Handicapped	44-in, max	in. above finished floor to flush valve control and easily accessible
Emergency Eye and Face Wash		
Handicapped	34-in, max 27-in	to receptor rim to spray head

3.2 ADJUSTING AND CLEANING

A. Stops or valves shall be adjusted for the intended water flow rate to fixtures without splashing, noise, or overflow.

B. At completion, the Contractor shall clean plumbing fixtures and equipment.

END OF SECTION

SECTION 23 05 00 – COMMON WORKS RESULTS FOR HVAC

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide heating, ventilating, and air conditioning systems and associated equipment complete with supports, mounting frames, ventilators, ductwork, piping, louvers, panels, filters, grilles, electric drive units and controls, mechanical equipment, electrical work, appurtenances, testing, and balancing, as indicated in accordance with the Contract Documents.

B. The equipment shall be installed ready for operation.

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
01 42 19	Reference Standards
09 96 00.10	High-Performance Coatings
23 05 93	Testing, Adjusting, and Balancing for HVAC
23 07 00	HVAC Insulation
23 23 00	Refrigeration Piping
26 00 00	Electrical Work, General
26 05 15	Industrial Control Panels
26 05 19	Wire and Cabling
26 05 33	Electrical Raceway Systems
26 05 43	Underground Raceways Systems
40 05 07	Pipe Supports
40 05 24	Steel Process Pipe

C. Reference Standards

Air Movement and Control Association International, Inc. (AMCA)	
American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)	
ASHRAE Standard 52-76/ASHRAE 52.1-1992 Standard	Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter

American Society of Civil Engineers (ASCE)	
ASCE 7-10	(2010; Errata 2011; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
American Society of Mechanical Engineers (ASME)	
Institute of Electrical and Electronics Engineers (IEEE)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 72	(2022) National Fire Alarm and Signaling Code
NFPA 90A	(2021) Standard for the Installation of Air Conditioning and Ventilating Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
Underwriters Laboratories (UL)	
UL 900	(2015) Standard for Air Filter Units

1.03 CONTRACTOR SUBMITTALS

A. Shop Drawings

1. Submit complete shop drawings and certificates, test reports, affidavits of compliance, for all equipment, ductwork and piping systems, in accordance with the requirements in Section 01 33 00 – Submittal Procedures, and as indicated in the individual equipment, piping or ductwork Sections.

2. Construction Drawings

   a. The HVAC Drawings define the general layout, configuration, routing, size and the general intent of the design. and are not fabrication drawings.

   b. The ductwork dimensions provided on the design drawings represent a free area and they are clear inside dimensions. The contractor shall be responsible to account for the loss of free area due acoustical lining, or any internal obstructions, and oversize the ductwork to provide the same free area as the one shown on the design drawings.

   c. It shall be the Contactor's responsibility to develop the Shop Drawings required for the construction of the HVAC system.

3. The Shop Drawings shall include all necessary dimensions and details regarding equipment, pipe and ductwork joints, fittings, valves, appurtenances, design calculations, and material lists.

4. The submittals shall include detailed layout, spool, or fabrication drawings which shall show all fittings, and supports as necessary to accommodate the equipment as a complete and functional system.

B. Equipment Numbers

1. Equipment is identified by assigned numbers for reference and location purposes in the Contract Documents.

2. Indicate the appropriate equipment numbers on the Shop Drawings and other submittals.

C. Furnish certified fan curves for each fan.

1.04 WARRANTY

A. Air conditioners, heaters, fans, ventilators, grilles, and the like, that are provided by the Contractor shall carry the manufacturer’s standard warranty.

B. Warranties shall be furnished to the Engineer upon final acceptance of the completed systems by the Owner.

C. Refrigerant compressors shall carry a manufacturer's 5-year warranty.

D. Control System

1. The temperature and equipment control system shall be warranted free from defects in workmanship and material under normal use and service for a period of one year after acceptance by the Engineer.

2. Equipment that proves to be defective in workmanship or material during the warranty period shall be adjusted, repaired, or replaced by the automatic control manufacturer as part of the Contract.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Quality

1. Mechanisms and other parts shall be amply proportioned for the stresses which may occur during operation and for any other stresses which may occur during fabrication and erection.

2. Individual parts furnished which are alike in all units shall be alike in workmanship, design, and materials, and shall be of the manufacturer's top-line, industrial-commercial grade.

B. Supports

1. Equipment and appurtenances shall be firmly anchored or connected to supporting members.

2. Equipment shall be supported on restrained spring-type vibration isolators.

3. Support as required for the proper installation of the equipment, but not forming an integral part of the building structure, shall be provided unless otherwise indicated.

C. Noise and Vibration Control

1. The system shall be free of objectionable vibrations and noise.

2. Provide flexible connections in ducts and piping connections to fans, compressors, and other vibrating equipment.

D. Seismic Restraints

1. Design the equipment, duct and piping supports and restraints for static, dynamic, and seismic loads in Zone 4 in accordance with the International Building Code.

2. Seismic restraints shall not induce stresses in the equipment, ductwork and piping caused by thermal expansion and contraction.

3. Comply with Section 01 33 17– Structural Design, Support and Anchorage.

2.02 MOTORS

A. Motors provided with the equipment shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics, including service factors.

B. Motors shall be in conformance with the requirements of Division 26.

C. Each motor shall bear the manufacturer's nameplate with complete motor data.

D. Each motor shall be of ample size and construction to continuously carry the loads which might be imposed by the equipment throughout the full range of operation of the equipment.

E. The maximum motor loading shall be less than or equal to the nameplate horsepower rating, exclusive of the service factor.

2.03 ELECTRICAL WORK

A. The Work of this Section shall include:

1. Provide controls, sensors and control panels relating to the HVAC systems, including starters, thermostats, motorized dampers, louver operators and other equipment as indicated.

2. Provide control wiring of 120-volt and less as indicated in this Section and in conformance the requirements of Division 26 – Electrical and Division 40 – Instrumentation and Control for Process Systems.

B. The Work of Division 26 shall include:

1. Provide local power disconnects, where required.

2. Provide circuit breakers, starters in motor control centers, and 120-, 208-, 240- and 480-volt power feeders from the starters and circuit breakers to the HVAC equipment, as indicated.

C. Enclosures shall be of the same NEMA class as the electrical equipment in the same area.

D. Low-voltage control wiring shall be in accordance with the National Electric Code.

E. Control wiring for line voltage 120-volt and higher shall be in conformance with the requirements of Section 26 05 19 – Wire and Cabling.

F. Control Panels shall be in conformance with the requirements of Section 26 05 15 – Industrial Control Panels.

G. Conduit shall be in conformance with the requirements of Section 26 05 33– Electrical Raceway Systems and Section 26 05 43 – Underground Raceway Systems.

2.04 DUCT SMOKE DETECTORS

A. Products

1. Furnish and install all duct smoke detectors whether shown on the drawings or required by code. If the project includes an existing fire alarm panel all signals from the duct smoke detectors shall be transmitted to the existing fire alarm panel. If the project does not include an existing fire alarm panel, and a new fire alarm panel is not required for any other reason, signals from the duct smoke detectors shall be transmitted to the HVAC automatic temperature control panel.

2. Air Handling Units and Fans

a. Provide duct smoke detectors on both the intake and the discharge of air handling units, and fans as required by code.

b. The detector shall shut off the respective air handling unit or fan upon the detection of smoke.

3. Smoke detectors shall operate on the photoelectric principle, and shall respond to a predetermined smoke density regardless of the rate of combustion, the distance between the detector and fire source, the combustible material, the temperature or velocity of the smoke, and whether the fire is in a confined or open area.

4. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory-set alarm point.

5. The smoke detectors shall be capable of operating at a humidity range of 10 to 90 percent RH.

6. The smoke detectors shall operate from a 24-VDC power source, and shall be Simplex, 4098 Series, ADT; Pyrotronics; or equal.

2.05 FLASHING

A. Equipment that passes through roofs of buildings or structures shall be provided with flashing as indicated.

B. Flashing shall be in conformance with the requirements of Section 13 34 19 – Metal Building Systems.

2.06 WELDING

A. The welding of black steel or alloy pipe shall be carried out in strict accordance with AWS procedures, current edition of ASME/ANSI B31.1 or B31.9 and the codes and ordinance of Skamania County and the State of Washington pertaining to welded steel pipelines.

B. Welding shall be accomplished by means of the shielded electric arc process and performed by workers who are certified for this Work.

2.07 EXPANSION JOINTS AND LOOPS

A. Provide expansion loops or expansion joints at the indicated locations and as necessary to provide for the expansion of piping.

B. The maximum straight run of pipe without an expansion joint or loop installed shall not exceed 75 ft.

C. Provide an expansion joint or loop at every building construction joint.

D. Construction

1. The pipe expansion joints on metal piping 3-in and smaller shall be of the 2-ply stainless steel bellows type, with a 1 ½-in compression stroke, a ½-in and smaller shall be of the 2-ply stainless steel bellows type, with a 1 ½-inextension and a total stroke of 2-in.

2. The joints shall be suitable for a maximum operating temperature of 750 deg F and a maximum working pressure of 175 psig.

3. The compensator shall have male pipe thread ends for steel pipe and female sweat ends for copper pipe.

E. Pipe Expansion Joints Manufacturers, or Equal

1. Flexonics, Model H for steel piping and Model HB for copper piping

2. Keflex Series 7Q

3. Adsco Compensators

2.08 HANGERS AND SUPPORTS

A. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2021 IBC Section 1613 with local amendments/ASCE 7-10 Chapter 13

B. Provide all necessary hangers, supports, concrete inserts, anchors and guides for material and equipment to be installed.

C. No perforated strap hangers and no wire supports will be accepted.

D. Insulation Allowance

1. Hangers supporting insulated pipe shall be sized to fit the pipe plus the insulation.

2. The insulation at support points shall be provided with a metal shield in order to prevent damage to the insulation.

E. Anchors and guides shall be constructed of steel, in accordance with approved Shop Drawings, and as indicated.

F. Pipe hangers used to support uninsulated copper piping shall be copper plated.

G. Anchors

1. Anchorages shall be obtained by welding lugs onto the pipe and providing abutting surfaces against the lugs to restrict longitudinal movement.

2. Anchors shall be designed such that the pipe may be removed by removing bolts; no welding of pipe to the anchor will be accepted.

3. bolting materials shall be cadmium plated.

H. Guides shall be located not more than 20 ft from each expansion loop or joint.

I. Horizontal runs of pipe shall be provided with supports spaced such that the sag of the unsupported length will not create any pockets in the piping (weight of fluid included).

J. Pipe support lengths shall be in conformance with the requirements of Section 40 05 07– Pipe Supports.

K. Vertical Piping

1. Vertical piping shall be:

a. Supported at the base with fittings made for this purpose; or

b. Supported from the nearest horizontal member or floor with a riser extension pipe clamp.

2. Provide a riser extension clamp on each floor.

L. Hangers for ductwork and equipment shall be as indicated and in accordance with the guidelines of the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

M. Inserts shall be galvanized.

2.09 PIPE SLEEVES

A. The Contractor shall examine the Drawings carefully for sleeves that are to be built into the construction and plan the Work accordingly, such that the sleeves are placed well in advance and care is taken with their location and support until encased.

B. Sleeves shall be fabricated from standard weight galvanized steel pipe for dry interior installations.

C. Sleeves for exterior or wet installations shall be fabricated from standard-weight ductile black steel, stainless steel, or standard-weight PVC for pipe temperatures below 120 deg F Sleeves shall be sized one pipe size larger than uninsulated piping and one pipe size larger than piping plus insulation for insulated pipe.

D. Locations

1. Where pipes pass through floors, sleeves shall extend 3-in above the finished floor.

2. Where pipes pass through walls, sleeves shall be flush with the wall.

2.10 MOTORIZED DAMPERS

A. General

1. Provide motorized opposed blade dampers as indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Design and Construction

1. The damper and frames shall be fabricated from aluminum with a minimum thickness of B&S 12-gauge.

2. The aluminum blades shall be provided with interlocking edges, with one center and two edge crimps, and brass bearings.

3. The frame shall be of welded channel construction and shall be provided with lugs and mounting brackets for damper operators.

4. The dampers shall be provided with felt or rubber seals at their edges to minimize air infiltration when closed.

C. Motors

1. Damper motors shall be electric with necessary linkages for positioning the damper blades.

2. The motors shall be powered open and spring-closed, unless otherwise indicated.

2.11 BACKDRAFT OR GRAVITY DAMPERS

A. General

1. Provide backdraft dampers on the exhaust fans and ventilators where indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Design and Construction

1. The dampers shall be of the multi-blade type, with soft-seating gaskets for minimizing noise and air leakage when closed.

2. Blades shall be constructed of 16-gauge aluminum and shall be of an air foil design.

3. Frames shall be fabricated from 16-gauge extruded aluminum alloy.

4. The frames shall be totally out of the air stream and arranged for flange mounting.

5. The dampers shall be designed to operate at 0.05-in w.g.S.P., or less.

6. Blades shall be individually counterbalanced and shall be provided with non-ferrous pins turning in nylon bearings.

C. Damper Manufacturers, or Equal

1. Air Balance, Inc.

2. Air Dynamic

3. Ruskin, Model BD2A1

2.12 VOLUME, CONTROL DAMPERS (MANUAL AND MOTORIZED)

A. General

1. Provide volume control dampers in accessible locations in branch supply ducts and at each exhaust air opening, in order to properly regulate the volume of air delivered or withdrawn from each inlet and outlet, and as indicated.

2. Damper sizes and capacities shall be as indicated on the Drawings.

B. Construction

1. The volume dampers shall be of the opposed blade type.

2. The dampers shall be constructed of aluminum, of B & S 14-gauge thickness.

3. The dampers shall be suitably reinforced with sturdy control shafts.

4. Ductwork shall be reinforced to double thickness at damper shaft openings.

C. Air Extractor Type

1. The volume control dampers indicated to be of the air extractor type shall be constructed of stainless steel, of 20-gauge for frames and of 24-gauge thickness for blades.

D. No splitter dampers will be accepted.

E. Manual control dampers shall be provided with mechanisms for adjustment and locking into position after being set.

F. Motors

1. Damper motors shall be electric with either modulating or 2-position control and necessary linkages.

G. The motors shall be powered open and spring-closed, unless otherwise indicated.

2.13 STATIONARY WALL LOUVERS

A. General

1. Provide wall louvers where indicated.

2. Provide louvers complete with aluminum bird screen and necessary linkages for the operating section.

3. Louver sizes and capacities shall be as indicated on the Drawings.

4. Louvers shall be of the adjustable type or fixed type as indicated or required and shall be provided with a drain gutter in each blade and downspouts in jambs and mullions.

5. The louvers shall be provided with an extended sill.

B. Construction

1. Stationary blades and adjustable blades shall be contained within a single 6-in louver frame.

2. The adjustable section shall include low-leakage blade and jamb seals.

3. Louver components, including heads, jambs, sills, blades, and mullions, shall be factory-assembled by the louver manufacturer.

4. The water stop at the sill shall be factory-caulked watertight.

C. Finish

1. Provide louvers with a Kynar® 500, or equal, finish.

2. The color of the louver shall be submitted for the Engineer's approval.

D. Performance

1. Submit published louver performance data bearing the AMCA Certified Ratings Seal for Air Performance & Water Penetration, for approval prior to fabrication.

2. The performance data shall demonstrate pressure drop and water penetration equal to or less than the indicated model.

E. Fixed-type wall louvers shall be with extruded 6063T5 aluminum alloy construction as follows:

1. Frame: 0.125-in wall thickness; box-type

2. Blades: stationary section and adjustable center pivoted section; 0.125-in wall thickness; 37 ½ degree angle on approximate 4 ½-in centers

3. Operator: electric-type; furnished with louver; 120-volt maximum

F. Manufacturer, or approved equal

1. Ruskin Model ELF 6375DX

2. Greenheck

2.14 PAINTING

A. All equipment located in the exterior or visible from the outside shall be painted with earthy or dark earth tones. Paint sample shall be sent to the Engineer, Architect and Owner for review and approval.

B. Painting of all other equipment and materials shall comply with the requirements of Section 09 96 00.10– High-Performance Coatings.

C. Touch-Ups

1. Touch up factory-painted surfaces that are rusted or scratched.

D. Clean finishes to be touched up to bright metal, prime with a corrosion inhibitor, and finish with a coating to match the original finish.

PART 3 -- EXECUTION

3.01 GENERAL

A. Openings - New Construction

1. Provide necessary openings in walls, floors, and roofs for the passage of heating and ventilating equipment in the buildings.

2. Openings shall be as indicated or as required to provide passage for heating and ventilating Work.

3. Provide hanger and support inserts into masonry or structural steel as required for proper completion of the Work.

3.02 BALANCING TESTING

A. Balancing Subcontractor

1. After the installation Work has been completed, the Contractor shall provide the services of an independent balancing subcontractor who shall perform necessary adjustments of volume dampers, volume controllers, exhaust fans, supply blowers, supply and return registers, and heating units.

B. Balancing Procedures

1. Balancing and testing shall be in conformance with the requirements of Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC.

3.03 COMMISSIONING OF HVAC

1. Commissioning of HVAC shall be in conformance with the requirements of Section 23 08 00 – HVAC Commissioning.

3.04 VIBRATION ISOLATORS

A. Install isolation equipment in strict compliance with the manufacturer's recommendations.

3.05 TEMPERATURE AND EQUIPMENT CONTROL

A. After completion of the installation, use trained personnel to adjust thermostats, and sensors in the motors and other provided equipment, and place them in complete operating condition subject to the approval of the Engineer.

B. Instruct the operating personnel in the operation of the control system.

END OF SECTION

SECTION 23 05 48 – VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 -- GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Section 01 33 17 – Structural Design, Support, and Anchorage, apply to this Section.

1.02 THE SUMMARY

A. Section Includes:

1. Isolation pads
2. Isolation mounts
3. Restrained elastomeric isolation mounts
4. Freestanding and restrained spring isolators
5. Housed spring mounts
6. Elastomeric hangers
7. Spring hangers
8. Spring hangers with vertical-limit stops
9. Pipe riser resilient supports
10. Resilient pipe guides
11. Seismic snubbers per Section 01 33 17 – Structural Design, Support, and Anchorage
12. Restraining braces and cables
13. Steel and inertia, vibration isolation equipment bases.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Definitions

1. IBC: International Building Code
2. ICC-ES: ICC-Evaluation Service

3. OSHPD: Office of Statewide Health Planning and Development for the State of California

C. Reference Specifications

01 33 17	Structural Design Support and Anchorage
01 79 00	Owner Staff Training

D. Reference Standards

American Association of State Highway and Transportation Officials (AASHTO)	
American Society of Civil Engineers (ASCE)	
ASCE/SEI 7-05	Minimum Design Loads for Buildings and Other Structures
ASCE 7-05	Wind Loads: Guide to the Wind Loads Provisions of ASCE 7-05
American Welding Society, Inc. (AWS)	
AWS D1.1/D1.1M	Structural Welding Code
ASTM International (ASTM)	
ASTM A36/A36M	Standard Specification for Carbon Structural Steel
ASTM A603	Standard Specification for Zinc-Coated Steel Structural Wire Rope
ASTM A492	Standard Specification for Stainless Steel Rope Wire
ASTM E488	Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements
Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
MSS SP-127	Bracing for Piping Systems: Seismic – Wind – Dynamic Design, Selection and Application

1.04 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:

1. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage

2. Site Class: E

3. Seismic Design category: D

a. Component Importance Factor, Ip:1.0

b. Risk Category: III

c. Component Response Modification Factor, Rp: varies, refer to ASCE 7-16 Table 13.6-1

d. Component Amplification Factor, ap: varies, refer to ASCE 7-16 Table 13.6-1

4. Analysis procedure: Equivalent Lateral Force (ELF) Procedure

5. Response modification coefficient (R): 3.25 or in accordance with PEMB

1.05 ACTION SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Comply with Section 01 33 17– Structural Design, Support, and Anchorage

5. Seismic- and Wind-Restraint Details:

a. Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.

b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

e. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer

B. Welding certificates

C. Field quality-control test reports

1.07 QUALITY ASSURANCE

A. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.

B. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage.

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 -- PRODUCTS

2.01 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Ace Mountings Co., Inc.

2. Amber/Booth Company, Inc.

3. California Dynamics Corporation

4. Isolation Technology, Inc.

5. Kinetics Noise Control

6. Mason Industries

7. Vibration Eliminator Co., Inc.

8. Vibration Isolation

9. Vibration Mountings & Controls, Inc.

B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.

1. Resilient Material: Oil- and water-resistant rubber or hermetically sealed compressed fiberglass.

C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge bearing neoprene as defined by AASHTO.

D. Restrained Mounts: All-directional mountings with seismic restraint.

1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge bearing neoprene as defined by AASHTO.

E. Spring Isolators: Freestanding, laterally stable, open-spring isolators.

1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.

3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

5. Baseplates: Factory drilled for bolting to structure and bonded to 0.24 in thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psi.

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 0.24 in thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Restraint: Seismic or limit stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.

2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 0.24 in travel up or down before contacting a resilient collar.

H. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

I. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.

7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of the required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 0.5 in thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 3.45 MPa and for equal resistance in all directions.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 0.5 in thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsert able to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements

2.02 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation

3. Isolation Technology, Inc.

4. Kinetics Noise Control

5. Mason Industries

6. Vibration Eliminator Co., Inc.

7. Vibration Isolation

8. Vibration Mountings & Controls, Inc.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1 in clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1 in clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

D. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.03 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation

3. Cooper B-Line, Inc.; a division of Cooper Industries

4. Hilti, Inc.

5. Kinetics Noise Control

6. Loos & Co.; Cableware Division

7. Mason Industries

8. TOLCO Incorporated; a brand of NIBCO INC.

9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

D. Restraint Cables: ASTM A603 galvanized or ASTM A492 stainless-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings and matched to type and size of anchor bolts and studs.

G. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.

H. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

I. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488. Minimum length of eight times diameter.

J. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488.

2.04 FACTORY FINISHES

A. Finish: Manufacturer's standard prime coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot dip galvanized metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected

D. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage.

3.02 APPLICATION

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where required to prevent buckling of hanger rods due to seismic forces.

C. Strength of Support and Seismic-Restraint Assemblies: Select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Refer to drawings for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.13 in.

3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 39.4 ft o.c.., and longitudinal supports a maximum of 78.7 ft o.c.

3. Brace a change of direction longer than 12.1 ft.

D. Install cables so they do not bend across edges of adjacent equipment or building structure.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

F. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

I. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.

4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage.

C. Perform tests and inspections.

D. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days' advance notice.

3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.

7. Measure isolator deflection.

8. Verify snubber minimum clearances.

9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

3.05 ADJUSTING

A. Adjust isolators after piping system is at operating weight.

B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

C. Adjust active height of spring isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.06 DEMONSTRATIONS

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Section 01 79 00 – Owner Staff Training

END OF SECTION

SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide HVAC Piping and Equipment, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Standards

ASME International (ASME)	
ASME A13.1	Scheme for the Identification of Piping Systems

1.03 CONTRACTOR SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

1.04 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 -- PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.031-in. minimum thickness and having predrilled or stamped holes for attachment hardware.

2. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in by 0.75-in.

3. Minimum Letter Size: 0.25-in for name of units if viewing distance is less than 24-in, 0.5-in. for viewing distances up to 72-in, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

4. Fasteners: Stainless-steel rivets or self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate

B. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 0.125-in thick, and having predrilled holes for attachment hardware.

2. Letter Color: Black.

3. Background Color: White.

4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

5. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in by 0.75-in.

6. Minimum Letter Size: 0.25-in for name of units if viewing distance is less than 24-in, 0.5-in for viewing distances up to 72-in, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on A4 bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 0.125-in thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in by 0.75-in.

F. Minimum Letter Size: 0.25-in for name of units if viewing distance is less than 24-in , 0.5-in for viewing distances up to 72-in , and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pre-tensioned Pipe Labels: Pre-coiled, semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, and as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1.5-in high.

2.04 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 0.125-in thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: White.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2.5-in by 0.75-in .

F. Minimum Letter Size: 0.25-in for name of units if viewing distance is less than 24-in , 0.5-in for viewing distances up to 72-in, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, and as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 1.5-inhigh.

2.05 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4-in by 7-in.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 -- EXECUTION

3.01 PREPARATION

A. Clean piping and equipment surface of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and locations as follows:

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 ft along each run. Reduce intervals to 25 ft in areas of congested piping and equipment.

B. Pipe Label Color Schedule:

1. Refrigerant Piping:

a. Background Color: Black.

b. Letter Color: White

3.04 DUCT LABEL INSTALLATION

A. Install plastic-laminated, self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Blue: For cold-air supply ducts.

2. Yellow: For hot-air supply ducts.

3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.

4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter concealed spaces and at maximum intervals of 50 ft in each space where ducts are exposed or concealed by removable ceiling system.

3.05 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 -- GENERAL

A. The Work included in this Section shall consist of the furnishing of all labor, instruments, tools, and services as required for the total system balancing of the heating, ventilating, and air conditioning (HVAC) systems as indicated in the Contract Documents.

B. The Work under this Section shall include the following items:

1. Preparation for balancing of air systems

2. Preparation of control systems

3. Notification requirements by the General Contractor of systems readiness

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Standards

Associated Air Balance Council (AABC)	
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)	
ASTM International (ASTM)	
American National Standards Institute (ANSI)	
ANSI S1.13	(2020) American National Standard Measurement of Sound Pressure Levels in Air

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.01 GENERAL

A. Testing, adjusting, and balancing (TAB) of the air conditioning systems and related ancillary equipment shall be performed by a certified, independent third-party, AABC Agency, selected and employed by the Contractor and approved by the Owner.

B. The preparation for and corrections necessary for the testing, adjusting, and balancing of these systems, as described herein, are the responsibility of the Contractor.

C. Make changes or replacements to fan sheaves and belts, dampers, valves, and the like, as may be required for correct balance as advised by the TAB firm, as part of the Work.

D. Provide and coordinate the services of qualified, responsible subcontractors, suppliers, and personnel, as required to correct, repair, or replace deficient items or conditions found during the course of the Project, including the testing, adjusting, and balancing period.

E. Operate the systems for the length of time necessary to properly verify their completion and readiness for TAB.

F. Scheduling

1. Project completion schedules shall allow for sufficient time to permit the completion of TAB services prior to Owner occupancy.

2. Allow adequate time for coordinating Owner-required services associated with the testing and balancing activities during the construction period and prior to Substantial Completion.

G. Accessibility

1. Install valves, dampers, and miscellaneous adjustment devices in a manner that will leave them accessible and readily adjustable.

2. Should any such device not be readily accessible, provide access as requested by the TAB firm.

3. Malfunctions encountered by TAB personnel and reported to the Contractor shall be corrected by the Contractor immediately such that the balancing work can proceed with minimal delays.

H. The TAB firm shall check, adjust, and balance the components of the HVAC system in order to obtain the optimal performance of the equipment.

I. The Work is intended to be accomplished after the system components are installed and operating as indicated and required.

J. It shall be the responsibility of the Contractor to place the equipment into service.

K. The following components of the HVAC systems shall be tested, adjusted, and balanced:

1. Air moving equipment

2. Air distribution systems

3. Heating and cooling systems

4. Control systems (testing and verification)

3.02 FIELD TESTING

A. During the progress of the work, tests shall be performed as indicated and as required by authorities having jurisdiction, including the local building department, the Owner, the Owner's insuring agency, and the Engineer.

B. Perform such tests as part of the Work, including qualified personnel, equipment apparatus, additional thermometer wells, gauge connections, instrument connections, and services as required to perform the tests.

C. Submit 6 copies of each complete test report to the Engineer for review and send 2 copies of the accepted report to the Owner.

3.03 DEFECTIVE WORK

A. Leaks, damage, and defects discovered or resulting from tests shall be repaired or replaced to a like-new condition.

B. Leaky pipe joints, ductwork, and the like, shall be removed and replaced with acceptable materials.

C. Reporting

1. During the balancing process, as abnormalities and malfunctions of equipment or components are discovered by the TAB personnel, the TAB firm shall advise the Engineer and Owner in writing such that the conditions may be corrected by the Contractor.

2. The written document need not be formal but must be understandable and legible.

3. The TAB firm shall not instructor direct subcontractors in any of the Work.

3.04 CONTRACTOR'S RESPONSIBILITIES

A. Have the building and air conditioning systems in complete operational readiness for the TAB Work to begin.

B. Allow sufficient time for the TAB firm to perform their Work within the construction schedule.

C. Complete the Work by systems or floors, whichever is the more efficient method for testing systems.

D. Scheduling

1. Within 2 weeks after the construction schedule has been developed, schedule a TAB coordination meeting to include the TAB firm, the Contractor and primary subcontractors, the Engineer, and the Owner, for the purpose of developing a testing schedule for the Project.

2. Submit copies of the proposed schedule to the TAB firm at least one week prior to the coordination meeting.

E. Promptly correct deficiencies of materials and workmanship identified as delaying completion of the TAB firm's Work.

F. Assume responsibility for added costs to the Owner resulting from failure to have the building and air conditioning systems ready for TAB when scheduled, and from failure to correct deficiencies promptly.

G. Coordinate with the TAB firm to compile and submit:

1. one set of HVAC specifications

2. one copy of relevant revisions, clarifications, and modifications

3. one complete set of Drawings, less the Civil and Structural sheets

4. one set of the HVAC floor plans of the conditioned spaces

5. one copy of approved submittal data for installed equipment

6. one copy of related changes as required to accomplish the indicated test procedures

3.05 TAB FIRM RESPONSIBILITIES

A. The following observations and tests shall be performed by the TAB firm:

1. During the construction submittal stage and before the submittal documents are finalized, review the mechanical and HVAC submittals, drawings and specifications for balance-ability and furnish commentary.

2. During construction, review approved HVAC submittals such as control diagrams, air handling devices, and the like, that pertain to TAB work and balancing.

3. Perform construction observations and submit a written report including the following topics.

a. The ductwork prior to insulation and ceiling cover-up

b. The piping prior to insulation and ceiling cover-up

4. Perform a pre-balance site review and submit a written report.

3.06 OPERATIONAL READINESS

A. "Operational readiness," as referred to in this Section, shall be defined as the time when the construction status of the building permits the closing of doors, windows, ceilings, and the like, to obtain simulated or projected operating conditions.

B. Operational readiness of the HVAC system shall require that the following items have been accomplished:

1. Air Distribution Systems

a. The installation conforms to the indicated design requirements.

b. Volume, smoke, and smoke/fire dampers have been properly located and are functional.

c. Dampers have tight closure and open fully with smooth and free operation.

d. Supply, return, exhaust, and transfer grilles, registers, diffusers, and terminal devices have been installed and secured in a fully open position.

e. Air handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, and the like, have been sealed to eliminate uncontrolled bypass or leakage of air.

f. Final clean filters are in place, coils are clean with fins straightened, bearings are properly greased, belts are aligned and tightened, and the system is completely operational.

g. It has been verified that all systems are operating within the design pressure limits of the piping and ductwork.

h. Fans (supply, return, and exhaust) are operating and verified for freedom from vibration, proper fan rotation and belt tension.

i. Heater elements in motor starters are of proper size and rating, in accordance with the starter manufacturer’s requirements.

j. Motor amperage and voltage have been recorded on each phase at start-up and verified that they do not exceed nameplate ratings.

2. \Automatic Controls

a. A meeting has been held with the Engineer, the TAB firm, and the Owner, for a pre-submittal review of the proposed controls strategy.

b. Control components have been installed in accordance with project requirements and are functional, including electrical interlocks, damper sequences, air and water resets, fire and freeze stats, high- and low-temperature thermostats, safeties, and the like.

c. Controlling instruments have been calibrated and set for design operating conditions, with the exception of components that require input from the TAB firm, but a default has been set.

1) Cooperate with the TAB firm and provide all software and interfaces to communicate with the system.

d. Controls, sensors, operators, sequences, and the like, have been checked before notifying the TAB firm that the Energy Management System is operational.

1) Furnish technical support (technicians and necessary computers) for a complete check of these systems.

e. Fire alarm detection devices, sequences, inter-locks, and the like, have been checked before notifying the TAB firm that the system is operational.

1) Checked devices shall include the Fireman's Override Panel.

2) Provide all detection devices (fire and smoke), complete with all smoke zones identified along with all alarm and event chart devices identified.

3) Certify that the systems are totally operational prior to the TAB beginning.

f. A start-up report has been submitted.

1) The start-up report shall include the submitted and actual RPM, and the actual and nameplate voltage and amperage of all motors.

2) This requirement applies to each piece of electrically driven air conditioning equipment in the system, including supply and exhaust fans, other fans of fractional horsepower, pumps, and the like.

3) Furnish the addresses and initial set points of all controlled devices.

3.07 NOTIFICATION OF SYSTEM READINESS

A. After the above operational readiness items have been accomplished, notify the Engineer in writing, certifying that the Work has been accomplished and that the building and the air conditioning systems are in operational readiness for testing, adjusting, and balancing.

B. With the notification, include a copy of tabulated data as required.

C. The Engineer will notify the TAB firm of the readiness for balancing, and forward copies of the Contractor's certification and tabulated motor voltages, currents, and RPM.

D. If the TAB firm has been notified as described above and the inspection reveals that the TAB services notification is premature, costs of the inspection and wasted work accomplished by the TAB firm shall be reimbursed to the appropriate parties by the Contractor.

3.08 TESTING AND BALANCING

A. In coordination with the TAB firm, submit an overview of system TAB procedures including:

1. An agenda

2. Field observation reports

3. System testing, including:

a. Traverses to be made

b. Instrumentation to be used

c. How correction factors for grilles and diffusers will be obtained

d. How measurements will be verified at maximum and minimum

e. How control components will be verified

4. Report forms with each systems components identified and numbered.

3.09 INSTRUMENTATION

A. Ensure that instruments being used are currently calibrated and listed in the TAB report, showing instrument description, serial number, and date of calibration.

B. The accuracy of instruments used shall be as indicated in the current AABC National Standards.

3.10 FINAL AIR BALANCE

A. When systems are complete and ready for operation, the TAB firm shall perform a final air balance for all air systems and record the results.

B. The volume of air for the supply, return, exhaust, and outside air equipment and terminals shall be tested and balanced within the tolerances of the AABC Standard.

C. Air handling unit and fan volumes shall be adjusted by changing fan speed.

D. Air distribution device volume shall be adjusted using the spin-in damper for flexible duct-connected devices, and the damper for duct-connected devices.

E. Air distribution devices shall be balanced with air patterns as indicated.

F. Duct volume dampers shall be adjusted to provide air volume to branch ducts where such dampers are indicated.

G. The general scope of balancing by the TAB firm shall include the following items:

1. Filters: Check air filters and filter media and balance only systems with essentially clean filters and filter media.

2. Fan Speed: Measure and record RPM at each fan speed.

3. Voltage and Amperage Readings: Measure and record the final operating amperages and voltage for each motor.

4. Static Pressure Profile

a. Static pressure profiles shall be measured and recorded across each supply fan, cooling coil, heating coil, return air fan, air handling unit filter, and exhaust fan, and at the furthest air device or terminal unit from the air handler supplying that device.

b. Furnish static pressure profiles for systems which do not perform as designed.

5. Equipment Air Flow: Adjust and record exhaust, return, outside, and supply air CFM and temperatures, as applicable, at each fan and coil.

6. Coil Temperatures

a. Set controls for full cooling and for full heating loads.

b. Read and record entering and leaving dry bulb and wet bulb temperatures (cooling only) at each cooling coil, heating coil, and HVAC terminal unit.

c. At the time of reading, record water flow and entering and leaving water temperatures.

d. In variable flow systems, adjust the air and water flow to design for all the above readings.

7. Zone Air Flow: Adjust each zone of multizone units, each HVAC terminal unit, and air handling unit for design CFM.

8. Outlet Air Flow

a. Adjust each exhaust inlet and supply diffuser, register and grille to within the tolerances shown in the AABC Standard.

b. Include all terminal points of air supply and all points of exhaust.

9. Maximum and minimum airflow on terminal boxes shall be adjusted, measured, and recorded.

3.11 SOUND

A. Read and record sound levels at up to 15 locations in the building designated by the Engineer and show that all areas are within acceptable sound levels in accordance with ASTM and ASHRAE Standard Test method for measurement of sound in commercial Spaces, or the American National Standard Institute's Methods for the Measurement of Sound Pressure Levels, ANSI S1.13.

B. Perform measurements using an octave band analyzer.

C. Conduct the tests when the building is quiet and in the presence of the Engineer.

3.12 TESTING OF TEMPERATURE CONTROL SYSTEMS

A. Coordinate with the Contractor in order to ensure that the most effective total system operation is within the design limitations, and to obtain a mutual understanding of the intended control performance.

B. Verify that all control devices are properly connected and operated by the intended controller.

C. Observe that all valves are properly installed in the piping system in relation to direction of flow and location.

D. Observe the calibration of all controllers.

E. Verify the proper application of all normally opened and normally closed valves.

F. Sensors

1. Observe the locations of all sensors in order to verify whether their position will allow them to sense the intended temperatures and pressures of the media accurately.

2. The Contractor shall relocate the sensors as deemed necessary by the TAB firm.

a. Verify that the sequence of operation for control modes is in accordance with approved Shop Drawings and as indicated.

b. Verify the proper operation of all interlock systems.

c. Perform variable volume system verification in order to assure the system and its components track, with changes from full flow to minimum flow.

3.13 TAB FINAL ACCEPTANCE AND BALANCING

A. At the time of TAB final acceptance inspection, the TAB firm shall recheck, in the presence of the Engineer, specific and random selections of data that were recorded in the certified test and balance report.

B. Points and areas for recheck shall be selected by the Engineer.

C. Measurements and test procedures shall be the same as the submitted and approved test and balance agenda.

D. Selections for verification, specific plus random, shall not exceed 10 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If 10 percent of the random verification tests demonstrate a measured flow deviation of 10 percent or more from that recorded in the certified test and balance report, the report shall be automatically rejected.

F. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test and balance report submitted, and a new inspection test made, as part of the Work.

G. Final Acceptance will not occur until after the successful completion of the TAB verification process.

END OF SECTION

SECTION 23 07 00 – HVAC INSULATION

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide pipe and equipment insulation, complete and in place, as indicated in accordance with the Contract Documents.

B. In addition to the insulation indicated, the Contractor shall insulate cold or hot piping and exhausts that could be hazardous to personnel upon contact.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Federal Specifications

HH-1-558B	Insulation Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)

D. Commercial Standards

ASTM International (ASTM)	
ASTM C547	Mineral Fiber Pipe Insulation
ASTM E84	Test Method for Surface Burning Characteristics of Building Materials
ASTM C1136	Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation
ASTM C1290	Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts
National Fire Protection Association (NFPA)	
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	Standard for the Installation of Warm Air Heating and Air Conditioning Systems
CGSB 51-GP-11M	Thermal Insulation, Mineral Fiber, Blanket for Piping, Ducting, Machinery and Boilers
CAN/CGSB-51.12	Cement, Thermal Insulating and Finishing

CAN/CGSB-51.40	Thermal Insulation, Flexible, Elastomeric, Unicellular, Sheet and Pipe Covering
CGSB 51-G-52MA	Vapor Barrier, Jacket and Facing Material for Pipe, Duct and Equipment Thermal Insulation
CAN/CGSB-51.53	Ploy (Vinyl Chloride) Jacketing Sheet for Insulated Pipes, Vessels and Round Ducts
CAN/ULC-S102	Surface Burning Characteristics of Building Material and Assemblies
CAN/ULC- S701	Thermal Insulation, Polystyrene, Boards and Pipe

1.03 CONTRACTOR SUBMITTALS

A. Submit complete Shop Drawings of thermal insulation, with manufacturer's data on materials, covering, jackets, and finish, in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Furnish the following certifications:

1. Certification from the heating system manufacturer that the insulation has been installed in accordance with the manufacturer's recommendations.

2. Certification from the acoustic insulation/duct lining manufacturer that the lining has the indicated sound absorption coefficients.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All piping, ductwork and equipment shall be insulated to meet or exceed the minimum requirements of ASHRAE 90.1.

B. Components of the insulation, including covering, mastics, and adhesives, shall have a flame-spread rating of not greater than 25 and a smoke development rating of not greater than 50, when tested in accordance with ULC-S102.

C. Ratings shall be as established by tests in accordance with ASTM E84, and the above federal and commercial specification standards.

D. Insulation shall be applied in strict accordance with the manufacturer's instructions.

2.02 DUCTWORK INSULATION

A. Supply ductwork and outside air ductwork shall be insulated as indicated under this Section.

B. Insulation shall be provided for air duct systems operating at internal air temperatures up to 250 deg F.

C. The finished duct system shall meet the requirements of NFPA 90A and 90B.

D. Duct wrap insulation shall meet the requirements of ASTM C1290, Type III, to a maximum service temperature of 250 deg F.

E. Facing material shall meet the requirements of ASTM C1136, Type II, when surface burning characteristics are determined in accordance with ASTM E84 with the foil surface of the material exposed to the flame.

F. Density and Thickness

1. Density: 1.5 lbs per cu ft.

2. Thickness: 1 ½-in or 2 in , as indicated

G. The duct wrap insulation shall consist of a blanket of glass fibers factory-laminated to a reinforced foil/ kraft (FRK) vapor retarder facing, with a 2-in wide (minimum) stapling and taping flange on one edge.

H. The duct wrap insulation shall provide installed R-values as indicated in the following table:

Density, lbs/cu ft	**Nominal Thickness, Inches**	**R-value[1,2], (hour) (sq ft) (deg F) per BTU**
1.50	1 ½	6.0
1.50	2	8.0

[1] *at 75 deg F mean temperature*

[2] *assumes 25 percent compression of insulation*

I. Exposed Ductwork

1. Ductwork with exterior insulation which is exposed to the weather shall be protected with an aluminum-magnesium alloy jacket having a minimum thickness of 0.016-in.

2. The jacketing shall include built-in isolation felt.

3. The jacket shall be lapped at least 3-in at joints and secured with stainless steel bands on 6-in centers.

J. Duct Lining

1. The fiberglass ductwork lining shall be 1-in thick and shall have a density 1 ½-lbs/cu ft.

2. The liner shall have a flame spread rating of 25 or less, a smoke development rating of 50 or less, an average thermal conductivity not to exceed 0.23 BTU-inch per (hour) (sq ft) (deg F) at a mean temperature of 75 deg F and shall be suitable for duct velocities up to 5,000 FPM.

3. The liner shall have sound absorption coefficients as follows:

Frequency, Hertz	125	250	500	1000	2000	4000	NRC
Sound absorption coefficient	0.15	0.55	0.71	0.94	1.03	1.05	0.80

4. The indicated duct sizes are the airway dimensions of the duct system which does not include provisions for the duct liner; therefore, the Contractor shall add the duct liner thickness to the indicated duct sizes.

K. Manufacturers, or Equal

1. Manville Products Corporation, Linacoustic-HP

2. Owens-Corning

PART 3 -- EXECUTION

3.01 GENERAL

A. Piping, fittings, and valves to be insulated shall be clean and dry prior to installation of insulation.

B. Piping indicated to be insulated shall be completely insulated inside structures, except where indicated otherwise.

C. Install in accordance with TIAC National Standards and Provincial Standards.

3.02 INSULATION OF STRAIGHT DUCT AND FITTINGS

A. Before applying the duct wrap, air ducts shall be clean, dry and tightly sealed at joints and seams.

B. Portions of the duct designated to receive duct wrap shall be completely covered with duct wrap.

C. Remove a 2-in piece of insulation from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.

D. Install duct wrap insulation with facing outside such that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap.

E. Adjacent sections of the duct wrap insulation shall be tightly butted and overlapped with the 2-in stapling and taping flap.

F. If the duct is rectangular or square, install insulation such that it is not excessively compressed at corners.

G. Seams shall be stapled approximately 6-in on center, using ½-in steel outward clinching staples.

H. Seams and joints shall be sealed with pressure-sensitive tape matching the insulation facing (either plain foil or FRK backing stock) or glass fabric and mastic.

I. Cloth duct tape of color or finish using reclaimed rubber adhesives will not be accepted for use on duct wrap insulation.

J. Where rectangular ducts are 24-in or greater in width, the duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18-i centers (maximum) to prevent the insulation from sagging.

K. Where a vapor retarder is indicated, seal tears, punctures and other penetrations of the duct wrap facing using one of the above methods to provide a vapor-tight system.

L. Damaged Insulation

1. The Contractor shall replace insulation that has been damaged or removed by modifications to the existing ductwork.

2. The replacement insulation shall be new and joints between new and existing insulation shall be made water-tight.

3.03 DUCTWORK INSPECTION

A. After completing the installation of the duct wrap and before operations are to commence, visually inspect the system and verify that it has been installed correctly.

B. Open system dampers and turn on fans to blow scraps and other loose pieces of material out of the duct system; allow for a means of removal of such material.

C. Check the duct system to ensure that there are no air leaks through joints.

3.04 FIBERGLASS INSULATION

A. Fiberglass insulation shall be securely held in place before the final covering is applied.

B. A scrim fabric, similar to a 20 x 10 thread count mesh and 100 percent fiberglass, shall be pasted in place to hold the pipe insulation securely to the pipe.

C. The scrim fabric shall be at least 4-in wide, with at least 2 applications per length of pipe insulation, and one at each joint.

3.05 JACKETING

A. Joints shall be neatly finished with no ragged ends.

B. When finished, the covering shall show no exposed staples or other binding used during installation.

C. Staples, if used, shall be stainless steel.

3.06 LAGGING FABRIC

A. The final lagging fabric shall be neatly pasted in place with a 3-in longitudinal overlap using a **Luben No. 9 adhesive**, or equal.

B. Each transverse joint shall have a 3-in butt strip of the same fiberglass fabric.

C. Final joints shall be neatly finished with no ragged ends and the covering shall present a neat, uniform surface when finished.

D. The fabric shall show no exposed staples or other binding used during construction; staples, if used, shall be stainless steel.

3.07 COMPRESSION COUPLINGS AND EXPANSION JOINTS

A. The rigid insulation blocks shall be held in place with stainless steel bands, approximately ½-in wide by 0.015-in thick.

B. After banding, the blocks shall be finished with a trowel coat of insulating cement to filling voids, and troweled to a smooth, neat finish.

C. The installation shall then be covered with an acoustical insulation consisting of a fiberglass fabric weighing 24.6 oz. per sq yd and coated with a loaded vinyl weighing 83.4 oz. per sq yd.

D. The acoustical insulation shall be **Alpha-Sonic Style No. 75**, or equal.

E. The acoustical insulation shall be covered with a 100-percent fiberglass lagging fabric as indicated.

END OF SECTION

SECTION 23 08 00 – COMMISSIONING OF HVAC

PART 1 -- GENERAL

1.01 SUMMARY

A. Related Documents

1. Drawings and general provisions of the Subcontract apply to this Section.

2. Review these documents for coordination with additional requirements and information that apply to Work under this Section.

B. Section Includes:

1. General requirements that apply to implementation of commissioning of HVAC systems, assemblies and components.

C. Reference Specifications

Division 23	HVAC Sections

D. Reference Standards

Associated Air Balance Council (AABC)
National Environmental Balancing Bureau (NEBB)

1.02 REFERENCES

A. General

1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.

2. Unless otherwise noted, the referenced standard edition is the current one at the time of commencement of the Work.

1.03 DESCRIPTION

A. The purpose of commission is to ensure the Owner and Engineer that Work has been completed as specified and that systems are functioning in the manner as described in the design documents and specified system operating criteria. It will assist operating staff training and familiarization with new systems. It will serve as a tool to reduce post-occupancy critical systems operational difficulty or failure. It will, also, be used to develop test protocol and record the associated test data in an effort to advance the building systems from a state of substantial completion to a full dynamic operation.

B. Commission will commence after preliminary punch list items are completed by Subcontractors.

C. The steps associated with commissioning are outlined below:

1. Step One - Installation Verification

2. Step Two - System Start-Up.

3. Step Three - Functional Performance Testing.

D. Operational staff training is essential to the commission process and will run concurrently with steps one through three.

E. The Commissioning Team will include representatives of the Owner, Construction and Installing Subcontractors, Test and Balance Subcontractor, Temperature Controls Subcontractor and Construction Subcontractor's Commissioning Agent. Equipment manufacturer's representatives will be present for start-up as specified in the equipment Specification Sections and for equipment training.

1.04 SYSTEMS TO BE COMMISSIONED

A. Commissioning will be performed on the following systems:

1. Controls System

2. Air Conditioning Equipment.

3. Central Supply and Return Air Systems.

4. Air Terminals.

5. Smoke Detection (HSSD) System

1.05 SUBMITTALS

A. Commissioning Plan as prepared by the prime Subcontractor or his Commissioning Agent.

B. Prime subcontractors or his Commissioning Agent shall provide Functional Performance Tests (FPT) procedures for the above listed systems. Prime subcontractors or his Commissioning Agent shall provide system narrative descriptions as part of the FPT procedures.

PART 2 -- PRODUCTS

2.01 COMMISSIONING PLAN

A. The commissioning plan shall outline the organization, scheduling, team members, and documentation pertaining to the overall commissioning process.

2.02 NARRATIVE DESCRIPTIONS

A. A narrative description of the design intents of the systems and their intended modes of sequences of operation.

2.03 FUNCTIONAL PERFORMANCE TESTS (FPT) PROCEDURES

A. The FPT procedures at the minimum shall consist of the following Sections:

1. Narrative Description:

a. This Section provides a narrative description of the design intents of the systems and their intended modes of sequences of operation.

2. Testing Prerequisites:

a. This Section contains verification that primary mechanical, electrical, and controls systems that support or interact with the system that the FPT is prepared against are completed, tested and operational.

3. Installation Verification:

a. This Section contains verification that the system installation is completed and is ready for commissioning.

4. Commencement of Functional Performance Testing:

a. This Section records the date and time of the start of system commissioning.

5. System Condition Prior to Staring Performance Testing:

a. This Section records the current set points and parameters of the system at the start of commissioning.

6. Functional Performance Test:

a. This Section shall provide the following:

1) Sequential steps required to set parameters and conditions required to test component and functions throughout intended ranges of operation.

2) Full range of checks and tests carried out to determine if electric and pneumatic connections, components, subsystems, systems and interfaces between systems function in accordance with the contract documents and design intents.

3) All modes and sequences of control operations, interlocks and conditional control responses and specified responses to abnormal emergency conditions.

7. End of Functional Performance Test:

a. This Section records the date and time of the end of system commissioning.

8. Field Notes:

a. This Section records notes or remarks during system commissioning.

9. List systems modifications, not required by the Contract Documents, but provided by the Subcontractor. List other questions regarding such system modifications.

10. List problems discovered during Commissioning that were corrected.

11. List problems discovered during Commissioning that were not corrected.

12. List recommended party that should take action on these problems.

PART 3 -- EXECUTION

3.01 GENERAL

A. The Subcontractors shall be responsible for performing procedures presented in specification and contract drawings as detailed in the Functional Performance Tests (FPT). Members of the designated Commissioning Team shall witness various portions of the commissioning process. Responsibilities for these activities are listed in the following paragraphs. Commissioning Team members shall sign-off on appropriate Sections after verifying installation, operation, or documentation. Final sign-off shall be by the Owner and Commissioning Agent.

B. Any test ports, gauges, test equipment, etc., needed to accomplish the functional performance tests shall be provided by Subcontractors.

C. Subcontractors shall provide to the Commissioning Team documentation of calibration of controls. Documentation shall include dates, setpoints, calibration coefficients, control loop verification, and other data required to verify system check-out. Documentation shall be dated and initialed by field engineer or technician performing the Work.

3.02 OPERATION STAFF TRAINING

A. System narrative descriptions will be prepared by the Commission Agent and supported by flow diagrams, one line diagrams, and appropriate Specification Sections for major systems to be commissioned. The Commission Agent will coordinate “system description” meetings with members of facility management and maintenance department groups to review system description documentation. The meetings will provide an overview of major system features, components, and arrangements.

B. The Subcontractor and associated manufacturer’s representatives shall provide required training to operational staff after the system description meetings have occurred. The Subcontractor training sessions shall provide a more detailed analogy of systems operation and maintenance.

3.03 INSTRUMENTATION

A. Instrumentation will be provided by the Subcontractor. Instruments used for measurements shall be accurate. Calibration histories for each instrument shall be available for examination. Calibration and maintenance of instruments shall be in accordance with the requirements of NEBB or AABC Standards.

B. Application of instruments and accuracy of measurements shall be in accordance with NEBB or AABC Standards.

3.04 DOCUMENTATION

A. The installing Subcontractor shall be responsible for collection of pertinent data during system start-up and functional performance testing. The Subcontractor shall submit to the Commissioning Agent documentation of tests performed prior to and after system start-up. Documentation shall also include start-up procedures as approved by Commissioning Team.

B. Documentation is to be typewritten on 8.5 by 11 in paper and inserted in a 2-in to 3-in thick three ring binder. Indicate the project name, number, volume number, and volume title on the end panel of each binder.

C. Provide a title sheet for each volume and list the following:

1. Volume Title and Section Name and Number requiring this submittal.

2. Project name, project number, and address.

3. Subcontractor name, address, and phone number.

4. Name, title, signature, and date of person making the submittal.

5. Name of Owner, a blank line for signature, and the date of person accepting the submittal.

6. Name, address, and phone number of Commission Agent; a blank line for signature; and date of person accepting the submittal.

D. Provide a Table of Contents for multiple submittals. List each submittal and page number. Number each page, centered on the bottom in sequential numerical order. Provide tabs for multiple submittals in a single binder.

3.05 STEP ONE – INSTALLATION VERIFICATION

A. General Commissioning responsibilities:

1. Before system start-up begins, the Commission Team shall conduct a final installation verification audit. The Subcontractor shall be responsible for completion of Work including change orders and punch list items to the Owner's satisfaction. The audit shall include, but not be limited to, checking of:

a. Piping specialties including balance, control, and isolation valves.

b. Ductwork specialty items including turning devices, balance, fire, smoke, control dampers, and access doors.

c. Control sensor types and location.

d. Identification of piping, valves, equipment, controls, etc.

e. Major equipment, pumps, valves, starters, gauges, thermometers, etc.

f. Documentation of prestart-up tests performed, including manufacturer's factory tests.

B. If Work is found to be incomplete, incorrect, or non-functional, the Subcontractor shall correct the deficiency before system start-up Work proceeds.

3.06 STEP TWO – SYSTEM START-UP

A. General Commissioning Responsibilities:

1. A start-up plan shall be developed and submitted by the installing Subcontractor. Start-up plan to include the following:

a. Flushing and cleaning of pipe.

b. Filters, strainers, and screens.

c. Valve/damper positions.

d. Electrical tests.

e. Pressure tests.

f. Safeties.

g. Chemical treatment.

h. Manufacturer's tests.

B. The start-up plan will be reviewed and a prestart-up inspection performed by designated members of the Commissioning Team. The installing Subcontractor shall commence with system start-up after approval has been given to start-up plan and the prestart-up inspection is completed. Designated members of the Commissioning Team shall witness system start-up and list system and equipment deficiencies noted during start-up. The Subcontractor shall take corrective action on system deficiencies noted and demonstrate to the Commissioning Team members suitable system operation.

3.07 STEP THREE – FUNCTIONAL PERFORMANCE TESTING

A. General Commissioning Responsibilities:

1. Functional Performance Testing begins after operational testing, adjusting, and balancing of the systems have been completed by the Subcontractors; and the System Description and Hands-on Training sessions have been completed.

2. The objective of the Functional Performance Testing is to advance the building systems from a state of substantial completion to full dynamic operation in accordance with the specified design requirements and design intent.

3. Attaining this object will be accomplished by developing individual systems testing protocols which, when implemented by the Subcontractor, will allow the Commissioning Team to observe, evaluate, identify deficiencies, recommend modifications, tune, and document the systems and systems equipment performance over a range of load and functional levels.

4. Functional Performance tests for the systems to be commissioned are defined in the Commissioning Plan. These tests are intended to be conclusive but may require minor modifications as system operation dictates.

END OF SECTION

SECTION 23 09 01 – INSTRUMENTATION AND CONTROL FOR HVAC SYSTEMS (STANDALONE SYSTEM)

PART 1 -- GENERAL

1.01 PRODUCTS FURNISHED AND INSTALLED UNDER THIS SECTION

A. Section 23 - Refrigerant Piping - The HVAC Subcontractor shall:

1. Furnish and install all pressure and temperature sensor wells and sockets, which are specified to be supplied by this Section.

B. Section 23 - Ductwork Accessories - The HVAC Subcontractor shall:

1. Furnish and install all duct smoke detectors whether shown on the drawings or required by code. If the project includes an existing fire alarm panel all signals from the duct smoke detectors shall be transmitted to the existing fire alarm panel. If the project does not include an existing fire alarm panel, and a new fire alarm panel is not required for any other reason, signals from the duct smoke detectors shall be transmitted to the HVAC automatic temperature control panel.

2. Furnish and install all automatic dampers and provide necessary blank off plates or transitions required to install dampers that are smaller than duct size.

3. Assemble multiple section dampers with required interconnecting and jackshaft linkage and extend required number of shafts through duct for external mounting of damper motors.

4. Furnish and install all necessary sheet metal baffle plates to eliminate stratification and provide the air volumes specified. Locate baffles by experimentation. Fix and seal permanently in place only after stratification problems have been eliminated.

5. Furnish and install airflow stations specified under this Section.

6. Furnish and install access doors or other approved means of access through ducts for service to control equipment.

C. Section 26 Electrical - The Electrical Subcontractor shall:

1. Furnish and install and connect all power wiring. Power wiring shall be defined as:

a. Wiring of all power feeds through all disconnect starters and variable speed controllers to electric motors.

b. Provide local power disconnects, where required.

c. Provide circuit breakers, starters in motor control centers, and 120-, 208-, 240- and 480-volt power feeders from the starters and circuit breakers to the HVAC equipment, as indicated.

d. Wiring of 120 VAC normal/emergency power feeds to all temperature control panels.

e. Power wiring to 120/277-volt single-phase motors shown on electrical plans and all VAV boxes shown (with or without fan motors).

f. All conduit, wiring and terminations between the ATC Panel and the Facility SCADA System

D. Section 23 Electrical - The HVAC Subcontractor shall:

1. Design and install a complete HVAC controls system as described herein and contract drawings.

2. Provide controls, sensors and control panels relating to the HVAC systems, including starters, thermostats, duct smoke detectors, motorized dampers, louver operators and other equipment as indicated.

3. Provide control wiring of 120-volt and less as indicated in this Section and in conformance the requirements of Division 26 – Electrical and Division 40 – Instrumentation and Control.

E. Enclosures shall be of the same NEMA class as the electrical equipment in the same area.

F. Low-voltage control wiring shall be in accordance with the National Electric Code.

G. Control wiring for line voltage 120-volt and higher shall be in conformance with the requirements of Division 26.

H. Conduit shall be in conformance with the requirements of Section 26 05 33 – Electrical Raceway Systems and Section 26 05 43 – Underground Raceway Systems.

1.02 DUCT SMOKE DETECTORS

A. General

1. Furnish and install all duct smoke detectors whether shown on the drawings or required by code. If the project includes an existing fire alarm panel all signals from the duct smoke detectors shall be transmitted to the existing fire alarm panel. If the project does not include an existing fire alarm panel, and a new fire alarm panel is not required for any other reason, signals from the duct smoke detectors shall be transmitted to the HVAC automatic temperature control panel.

2. Air Handling Units and Fans

a. Provide duct smoke detectors on both the intake and the discharge of air handling units, and fans as required by code.

b. The detector shall shut off the respective air handling unit or fan upon the detection of smoke.

3. Smoke detectors shall operate on the photoelectric principle and shall respond to a predetermined smoke density regardless of the rate of combustion, the distance between the detector and fire source, the combustible material, the temperature or velocity of the smoke, and whether the fire is in a confined or open area.

4. The detectors shall be designed to ignore invisible airborne particles or smoke densities that are below the factory-set alarm point.

5. The smoke detectors shall be capable of operating at a humidity range of 10 to 90 percent RH.

6. The smoke detectors shall operate from a 24-VDC power source, and shall be Simplex, 4098 Series, ADT; Pyrotronics; or equal.

1.03 RELATED SECTIONS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. The General Conditions of the Contract, Supplementary Conditions, and General Requirements are a part of this Specification and shall be used in conjunction with this Section as a part of the contract documents. Consult them for further instructions pertaining to this Work. The Contractor is bound by the provisions of Division 0 and Division 1.

C. The following Sections constitute related Work:

01 33 00	Submittal Procedures
23 05 00	Common Work Results for HVAC
26 05 19	Wire and Cabling
26 05 33	Electrical Raceway Systems
26 05 43	Underground Raceway Systems

D. Reference Standards

1. All Work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities having jurisdiction.

2. Such codes, when more restrictive, shall take precedence over the Contract Documents.

E. The installation shall comply with the following codes:

American National Standards Institute (ANSI)
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)

ASHRAE Standard 135	A Data Communication Protocol for Building Automation and Control Networks
ASHRAE/ANSI	135-2001: Data Communication Protocol for Building Automation and Control Systems (BACNET)
International Building Code (IBC)	
International Mechanical Code (IMC)	
National Electric Code (NEC)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 72	National Fire Alarm and Signaling Code
Underwriters Laboratories (UL)	

1. All BAS DDC controllers and local user displays shall be UL-listed under Standard UL 916, category PAZX and Standard ULC C100, category UUKL7.

2. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and labeled as such.

1.04 SYSTEM DESCRIPTION

A. Performance Standards

1. The system shall conform to the minimum standards indicated in Tables 1 and 2, below.

2. Information transmission and display times shall be based upon network, rather than modem, connections.

3. Programmable controllers shall be capable of executing DDC PID control loops at a selectable frequency adjustable down to once per second.

4. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.

5. The system shall report all values with end-to-end accuracy as listed or better than those listed in Table 1.

6. Control loops shall maintain measured variable at set point within the tolerances listed in Table 2.

TABLE 1 - REPORTING ACCURACY

MEASURED VARIABLE	REPORTED ACCURACY
Space Temperature	plus or minus 1 deg F
Ducted Air	plus or minus 1 deg F
Outside Air	plus or minus 2 deg F

MEASURED VARIABLE	REPORTED ACCURACY
Dew Point	plus or minus 3 deg F
Water Temperature	plus or minus 1 deg F
Delta-T	plus or minus 0.25 deg F
Relative Humidity	plus or minus 5 percent RH
Water Flow	plus or minus 5 percent of full scale
Airflow (terminal)	plus or minus 10 percent of full scale (see Note 1)
Airflow (measuring stations)	plus or minus 5 percent of full scale
Airflow (pressurized spaces)	plus or minus 3 percent of full scale
Air Pressure (ducts)	plus or minus 0.1-in w.g.
Air Pressure (space)	plus or minus 0.01-in w.g.
Water Pressure	plus or minus 2 percent of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	5 percent of reading (see Note 3)
Carbon Monoxide (CO)	plus or minus 5 percent of reading
Carbon Dioxide (CO2)	plus or minus 50 ppm

Note 1: 10 percent to 100 percent of full scale
Note 2: for both absolute and differential pressure
Note 3: not including utility-supplied meters

TABLE 2 - CONTROL STABILITY AND ACCURACY

CONTROLLED VARIABLE	CONTROL ACCURACY	RANGE OF MEDIUM
Airflow	plus or minus 10 percent of full scale	-----
Space Temperature	plus or minus 2 deg F	-----
Duct Temperature	plus or minus 3 deg F	-----
Humidity	plus or minus 5 percent RH	-----

1.05 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. No Work may begin on any segment of the Project until submittals have been successfully reviewed for conformity with the design intent.

C. Submittals shall include:

1. Direct Digital Control System Hardware

a. A complete bill of materials of equipment to be used, indicating quantity, manufacturer, model number, and other relevant technical data.

b. Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation and maintenance instructions for the following items and other relevant items not listed:

1) Direct Digital Controller (controller panels)

2) Transducers/Transmitters

3) Sensors (including accuracy data)

4) Actuators

5) Valves

6) Relays/Switches

7) Control Panels

8) Power Supply

9) Batteries

10) Wiring

2. Wiring diagrams and layouts for each control panel, showing all termination numbers.

3. Schematic diagrams for all field sensors and controllers, and floor plans of all sensor locations and control hardware.

4. Diagrams

a. Submit schematic diagrams for all control, communication, and power wiring.

b. Submit a schematic drawing of the central system installation. Show all interface wiring to the control system.

c. Submit riser diagrams of wiring between central control unit and all control panels.

D. Controlled Systems

1. Schematic Diagrams

a. Submit a schematic diagram of each controlled system.

b. Indicate all control points labeled, with point names shown or listed.

c. Graphically show the location of all control elements in the system.

2. Schematic Wiring Diagrams

a. Submit a schematic wiring diagram for each controlled system.

b. Label all elements.

c. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name.

d. Label all terminals.

3. Instrument List

a. Submit an instrumentation list for each controlled system.

b. Each element of the controlled system shall be listed in table format.

c. The table shall show element name, type of device, manufacturer, model number, and product data sheet number.

4. Description

a. A complete description of the operation of the control system, including sequences of operation.

b. Include and reference a schematic diagram of the controlled system.

5. I/O

a. Submit a points list for each system controller, including both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, and the location of the I/O device.

6. Quantities of items submitted will be reviewed but this shall be the responsibility of the Contractor.

1.06 QUALITY ASSURANCE

A. All products used in this project installation shall be new and currently under manufacture and shall be the version currently being sold by the manufacturer for use in new installations.

B. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner in writing. Spare parts shall be available for at least five years after completion of this contract.

1.07 WARRANTY

A. Labor and materials for the control system specified shall be warranted free from defects for a period of 12 months after final completion and Owner receives beneficial use of the system.

B. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

C. The Contractor shall respond to the Owner's request for warranty service within 24 hours during normal business hours.

D. All Work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up.

E. If the Work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Temperature Controls

1. The temperature control system shall be as indicated on contract documents and shall consist of DDC controllers.

2. HVAC Subcontractor shall be responsible for the installation, calibration, and operator training as necessary for a complete and full operating temperature control system.

3. The temperature control system shall be a complete stand-alone building automation system, modular in construction and not requiring a central computer for operation or programming.

4. All programming shall be possible from a keypad/display on any field panel or from a remote computer.

5. Systems which do not have a keypad/display capability shall be provided with a portable interface with required cables and software.

B. BAS Components

1. The basic elements of the Building Automation System (BAS) structure shall be built from only standard components kept in inventory by the BAS supplier.

2. The components shall not require customizing other than setting jumpers and switches, and adding firmware modules, software modules or software programming to perform required functions.

3. The BAS shall possess a fully modular architecture, permitting expansion through the addition of more DDCP units, sensors, actuators, and operator terminals.

4. Expansion beyond this must be able to be accomplished in additional panels or expansion modules without abandoning any initial equipment.

C. Direct Digital Control Panel

1. The Direct Digital Control Panel's (DDCP's) software shall include a complete operating system, control algorithm application packages, and a complete custom control, calculation application package to accomplish the indicated sequence of operation.

2. In addition to pre-programmed package software, DDCP controllers shall be provided with field-flexible programming capabilities without the use of external equipment such as EPROM programmers in order to meet the indicated requirements.

3. Each DDCP shall be capable of performing all specified control functions in a completely independent manner.

4. Each DDCP unit shall be capable of sharing point information with other such units, such that control sequences or control loops executed at one control unit may receive input signals from sensors connected to other units within the network.

D. Programming

1. Control software shall utilize “block” programming techniques connecting tested control blocks to form control sequencing.

2. Line-by-line programming requiring complete definition will not be accepted as a programming technique.

3. The programmer shall fill in the control parameters for each block to perform the required control sequence.

2.02 CONTROLLER SOFTWARE

A. Each intelligent field panel shall be completely user programmable and shall include the indicated programs installed in the base operating system.

B. Alarms

1. The alarm program shall provide for alarm reporting as follows:

a. Pilot light indication at local ATC Panel

b. Remote annunciation of identified alarm to facility SCADA System via hardwired contact closure

C. Analog Input Scaling

1. Analog inputs shall be scaled and labeled to read out in engineering units of the variable being measured (e.g., deg, CFM, etc.).

D. Analog Outputs

1. Each analog output shall be user programmable to be direct or reverse acting and vary the output between 2 and 10 VDC.

2. The panel shall allow the user to program minimum and maximum output levels as well as a manual fixed output level.

3. The analog output shall be assignable to operate based on any physical input or calculated value on the network.

E. System Calendar

1. Each panel other than Application Specific Controllers (such as Terminal Controllers) shall be provided with a 365/366-day battery-backed clock, with an automatic daylight savings time switch-over on the day entered.

F. PID Control

1. In order to provide precise control, each analog output shall be programmable with a proportional plus integral plus derivative (PID) program.

2. Individual constants shall be programmable for the P, I, and D functions.

3. The integral time interval shall be user programmable.

4. The current proportional term, the integral term, and the PID sum shall be dynamically displayed on the screen to provide assistance to start-up and service personnel in tuning the system.

G. The diagnostics program in each panel shall monitor and report system status.

2.03 BUILDING CONTROLLERS

A. General

1. Provide an adequate number of Building Controllers to achieve the indicated performance.

2. Each controller shall meet the following requirements.

a. The Building Controller shall be provided with sufficient memory to support its operating system, database, and programming requirements.

b. Controllers that perform scheduling shall be provided with a real-time clock.

B. Communication

1. The Building Controller shall be provided with a service communication port for connection to a portable operator terminal.

C. Environment

1. Building Controller hardware shall be suitable for the anticipated ambient conditions.

2. Controllers used outdoors or in wet ambient conditions shall be mounted within waterproof enclosures and shall be rated for operation at minus 40 deg to plus 150 deg F.

3. Controllers used in conditioned space shall be mounted in dust-protective enclosures and shall be rated for operation at 32 deg F to 120 deg F.

D. Keypad

1. Provide a local keypad and display or a connection for a portable operator terminal for each Building Controller.

2. The keypad shall be provided for interrogating and editing data.

3. An optional system security password shall be available to prevent unauthorized use of the keypad and display.

4. If the manufacturer does not provide this keypad and display, provide a portable operator terminal.

E. Serviceability

1. Provide diagnostic LEDs for power, communication, and processor.

2. All wiring connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.

F. Memory

1. The Building Controller shall maintain all BIOS and programming information in the event of a power loss for at least 72 hours.

2. Applications shall be maintained in flash memory.

G. Immunity to Power and Noise

1. The controller shall operate at 90 percent to 110 percent of its nominal voltage rating and shall perform an orderly shutdown below 80 percent nominal voltage.

2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

2.04 INPUT/OUTPUT INTERFACE

A. Hardwired inputs and outputs may tie into the system through building controllers, advanced application controllers, or application-specific controllers.

B. Input points and output points shall be protected such that shorting of the point to itself, to another point, or to ground will cause no damage to the controller.

C. All input and output points shall be protected from voltage up to 24 V of any duration, such that contact with this voltage will cause no damage to the controller.

D. Binary Inputs

1. Provide binary inputs to allow the monitoring of ON-OFF signals from remote devices.

2. The binary inputs shall provide a wetting current of at least 12 mA in order to be compatible with commonly available control devices and shall be protected against the effects of contact bounce and noise.

3. Binary inputs shall sense “dry contact” closure without external power (other than that provided by the controller) being applied.

2.05 AUXILIARY CONTROL DEVICES

A. General

1. All materials and equipment used shall be standard components, of regular manufacture for this application.

2. All systems and components shall have been thoroughly tested and proven in actual use.

3. Exceptions to the indicated requirements will not be accepted.

B. Airflow Measurement Devices (AMD) with Temperature and Airflow Alarming Capability

1. Airflow measurement devices shall use the principle of thermal dispersion and provide one self-heated bead-in-glass thermistor and one zero power bead-in-glass thermistor at each sensing node.

a. Thermal dispersion devices that indirectly heat a thermistor are not acceptable.

b. The manufacturer's authorized representative shall review, approve placement and the operating airflow rates for each measurement location indicated on the plans.

c. Provide one AMD for each measurement location provided on the plans, schedules and/or control diagrams to determine the average airflow rate and temperature at each measurement location.

2. Each AMD shall be provided with a microprocessor-based transmitter and one or more sensor probes.

a. Devices that have electronic signal processing components on or in the sensor probe are not acceptable.

3. Airflow measurement shall be field configurable to determine the average actual or standard mass airflow rate.

a. Actual airflow rate calculations shall have the capability of being adjusted automatically by the transmitter for altitudes other than sea level.

4. Temperature measurement shall be field configurable to determine the velocity weighted temperate or simple arithmetic average temperature.

5. Sensor Probes

    a. Sensor probes shall be constructed of gold anodized, 6063 aluminum alloy tube insert 316 stainless steel tube in lieu of 6063 aluminum alloy tube, when required.

    b. Sensor probe mounting brackets shall be constructed of 304 stainless steel.

    c. Probe internal wiring between the connecting cable and sensor nodes shall be Kynar coated copper. PVC jacketed internal wiring is not acceptable.

    d. Probe internal wiring connections shall consist of solder joints and spot welds. Connectors of any type within the probe are not acceptable. Printed circuit boards within the probe are not acceptable.

    e. Probe internal wiring connections shall be sealed and protected from the elements and suitable for direct exposure to water.

    f. Each sensor probe shall be provided with an integral, FEP jacket, plenum rated CMP/CL2P, UL/cUL Listed cable rated for exposures from minus 67 deg F to 392 deg F and continuous and direct UV exposure. Plenum rated PVC jacket cables are not acceptable.

    g. Each sensor probe cable shall be provided with a connector plug with gold plated pins for connection to the transmitter.

    h. Each sensor probe shall contain one or more independently wired sensing nodes.

    i. Sensor node airflow and temperature calibration data shall be stored in a serial memory chip in the cable connecting plug and not require matching or adjustments to the transmitter.

    j. Each sensor node shall be provided with two bead-in-glass, hermetically sealed thermistors potted in a marine grade waterproof epoxy. Devices that use epoxy or glass encapsulated chip thermistors are not acceptable.

    k. Each thermistor shall be individually calibrated at a minimum of 3 temperatures to NIST-traceable temperature standards.

    l. Each sensor node shall be individually calibrated to NIST-traceable airflow standards at a minimum of 16 calibration points.

    m. The number of independent sensor nodes provided shall be as follows:

Area ft^2	**# Sensor Nodes**
≤ 0.5	1

Area ft^2	# Sensor Nodes
> 0.5 & ≤ 1	2
> 1 & ≤ 2	4
> 2 & ≤ 4	6
> 4 & ≤ 8	8
> 8 & ≤ 12	12
> 12 & ≤ 14	14
> 14	16

n. A total of 4 probes shall be required for openings with an aspect ratio ≤ 1.5 and with an area ≥ 25 ft^2 .

6. Transmitter

a. A remotely located microprocessor-based transmitter shall be provided for each measurement location.

b. The transmitter shall be comprised of a main circuit board and interchangeable interface card.

c. All printed circuit board interconnects, edge fingers, and test points shall be gold plated.

d. All printed circuit boards shall be electroless nickel immersion gold (ENIG) plated.

e. All receptacle plug pins shall be gold plated.

f. The transmitter shall be capable of determining the average airflow rate and temperature of the sensor nodes.

g. Separate integration buffers shall be provided for display airflow output, airflow signal output (analog and network) and individual sensor output (IR-interface).

h. The transmitter shall be capable of providing a high and/or low airflow alarm.

i. The transmitter shall be capable of identifying an AMD malfunction via the system status alarm and ignore any sensor node that is in a fault condition.

j. The transmitter shall be provided with a 16-character, alpha-numeric, LCD display.

k. The airflow rate, temperature, airflow alarm and system status alarm shall be visible on the display.

l. The transmitter shall be provided with two field selectable (0-5/0-10 VDC or 4-20mA), scalable, isolated and over-current protected analog output signals and one isolated RS-485 (field selectable BACnet MS/TP or Modbus RTU) network connection.

m. Analog output signals shall provide the total airflow rate and be field configurable to output one of the following: temperature, airflow alarm; or system status alarm

n. Network communications shall provide the average airflow rate, temperature, airflow alarm, system status alarm, individual sensor node airflow rates and individual sensor node temperatures.

o. The transmitter shall be powered by 24 VAC and use a switching power supply that is over-current and over-voltage protected.

p. The transmitter shall use a “watchdog” timer circuit to ensure continuous operation in the event of brown-out and/or power failure.

7. Performance

a. Each sensing node shall have an airflow accuracy of ±2% of reading over an operating range of 0 to 5,000 FPM.

b. Accuracy shall include the combined uncertainty of the sensor nodes and transmitter.

c. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with this requirement over the entire operating range.

d. Each sensing node shall have a temperature accuracy of plus minus 0.18 deg F over an operating range of minus 20 deg F to 160 deg F.

8. Listings and Certifications

a. The AMD shall be UL873 Listed as an assembly.

b. Devices claiming compliance with the UL Listing based on individual UL component listing are not acceptable.

c. The AMD shall be BTL Listed.

d. The AMD shall carry the CE Mark for European Union Shipments.

9. Installation

a. Install in accordance with manufacturer’s placement guidelines. A written report shall be submitted to the consulting mechanical engineer if any discrepancies are found.

10. Adjusting

a. The AMD shall not be adjusted to match field measurements without approval from the consulting mechanical engineer when installations meet or exceed manufacturer's suggested placement

11. Acceptable Manufacturers or equal:

a. EBTRON, inc. model GTX116-P is the basis of design

b. Sierra

c. Johnson Controls

C. Damper Actuators

1. Electronic damper actuators shall be of the direct-couple rotary type, suitable for mounting directly on the damper end shaft.

2. Electronic damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range.

3. On dampers with multiple sections, provide one actuator per section.

4. Damper actuators used on economizers and outside air dampers shall be of the spring return type.

D. Control Panels

1. All direct digital controllers mounted on HVAC equipment located indoors shall be installed in NEMA 4X enclosures.

2. All direct digital controllers mounted on HVAC equipment located outdoors shall be installed in NEMA 4X enclosures.

3. Enclosures shall be of suitable size to accommodate power supplies, relays, and accessories as required for the application.

4. Each enclosure shall include a subpanel for direct mounting of the enclosed devices, including matched key locks for all enclosures.

5. Construction

a. Control panels shall contain all relays, control switches, transformers, pilot lights, timers, time clocks, step controllers, gages, thermostats, and other accessories as necessary for the particular system.

b. The panels shall be constructed of aluminum with a baked enamel finish and shall include a hinged front door with locking handle.

c. All manual switches and direct-reading gauges shall be flush-mounted on the front face and identified by engraved and riveted Bakelite or laminated plastic nameplates with white letters on black background.

d. Manual switches shall be of heavy-duty, oil-tight construction.

6. Wiring

a. Control devices shall be pre-wired internally.

b. Terminate all wires leaving the panel at separate numbered terminal strips.

c. Provide individual connectors for every item of mechanical equipment, all integral and remote pilot lights, and other devices indicated for each panel.

d. Power and control circuit requirements shall be as indicated on the Electrical Drawings.

e. Identify all wires by color coding or numerical tags at both ends.

f. Wire each control device without splices to the terminal strip.

g. Provide integral circuit protection for all panel-mounted control devices.

h. Wire each panel with a single 20-amp, 120-volt, and AC feeder.

7. Panel electrical wiring diagrams shall be secured to the inside of the panel door.

E. Float Switches

1. Provide float switches in condensate drain pans as required by code.

2. Float switches shall utilize a magnetically actuated dry reed switch.

3. The float shall be constructed of seamless polypropylene.

4. The switch shall be SPDT-rated for 16A (non-inductive) at 120VAC.

F. Smoke Detectors

1. Division 26 – shall provide area smoke detectors and wire into the fire alarm system in accordance with the requirements of Section 23 05 00 – Common Works for HVAC.

2. Division 23 – shall provide HVAC duct detectors interlock wiring between duct smoke detectors and starter safety circuits.

G. Current Sensing Relays

1. Provide current switches for indication of equipment status.

2. Amperage ratings shall be adjustable, with the desired set point being within the top 50 percent of the current relay's operating range.

3. Current sensing relays shall incorporate trip indication LEDs and shall be sized for proper operation with the equipment served.

H. Thermostats - Line Voltage

1. Materials: cold-rolled steel; beige thermoplastic; liquid sensing element

2. Contact Rating

   a. 6 amps running; 36 amps locked rotor; 120 VAC

   b. 3.5 amps running; 21 amps locked rotor; 208 VAC

   c. 3.0 amps running; 8 amps locked rotor; 240 VAC

3. Switch Action: single-pole, double-throw; open on rising temperature

4. Sensing Element: coiled bulb and capillary

5. Range: 0 to 130 deg F

6. Manufacturer, or Equal

   a. Dry Locations (no hose valves or open water processes in room): **Johnson Controls Model A19BAC-1** in NEMA 1 enclosure

   b. Wet (hose valves or open water processes in room) or Outdoor Locations: **Johnson Controls Model A19PRC-1** in NEMA 4X enclosure.

I. Selector Switches

1. Selector switches shall be of the 2- or 3-position, knob or key type as required by the sequence of operation.

2. Selector switches shall be of oil-tight construction and fitted with snap-fit contact blocks rated for 10A, 600 Vac/dc operation.

3. Provide labels indicating switch position.

J. Pushbutton Switches

1. Pushbutton switches shall be of either the maintained or momentary type as required by the sequence of operation.

2. Pushbutton switches shall be of oil-tight construction and fitted with snap-fit contact blocks rated for 10A, 600 Vac/dc operation.

3. Provide labels indicating switch function.

K. Pilot Lights

1. Provide pilot lights as required by the sequence of operation.

2. Pilot lights shall utilize multi-colored dome lenses and replaceable LED lamps.

3. Provide labels indicating light function.

2.06 WIRING AND RACEWAYS

A. Provide copper wiring, plenum cable, and raceways as indicated in the applicable Sections of Division 26 – Electrical.

B. All insulated wire shall be copper conductor, and UL-labeled for 194 deg F minimum service.

2.07 CONTROL SYSTEM MANUFACTURERS, OR EQUAL

A. Schneider Electric

B. Johnson Controls

C. Siemens

D. Honeywell

E. Trane

F. The above list of manufacturers applies to controller software, custom application programming language, building controllers, custom application controllers; and application specific controllers; all other indicated products (e.g., sensors, valves, dampers and actuators) need not necessarily be manufactured by the above manufacturers.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. The Drawings shall be thoroughly examined for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

B. Inspect the Project Site to verify that the equipment may be installed as indicated, and report any discrepancies, conflicts, or omissions to the Engineer for resolution before rough-in work is started.

C. Examine the Contract Documents for other parts of the Work, and if head room or space conditions appear inadequate, report these discrepancies to the Engineer and obtain written instructions for any changes that may be necessary to accommodate the Work with the work of others.

D. Changes in the Work made necessary by the failure or neglect of the Contractor to report such discrepancies shall be considered to be part of the Contract.

3.02 COORDINATION

A. Site

1. Where the Work will be installed in close proximity to, or will interfere with, the work of other trades, the Contractor shall assist in accommodating space conditions to make a satisfactory adjustment.

2. If the Contractor installs the Work before coordinating with other trades, so as to cause any interference with the work of other trades, the Contractor shall make the necessary changes in the Work in order to correct the condition as part of the Contract.

3. Coordinate and schedule the Work with all other work in the same area, or with work that is dependent upon other work, in order to facilitate mutual progress.

B. Coordination with Other Controls

1. Other controls and control devices that are to be part of or integrated into the control system specified in this Section. These controls shall be integrated into the system and coordinated by the Contractor as follows:

2. All communication media and equipment shall be provided as specified in Part 2, “Communication” of this Specification.

3. Each supplier of a control product is responsible for the configuration, programming, startup, and testing of that product to meet the sequences of operation described in this Section.

4. The HVAC Subcontractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other Sections or divisions of this Specification.

5. The HVAC Subcontractor is responsible for the integration of control products provided by multiple suppliers regardless of where this integration is described within the contract documents.

C. Coordination with Facility SCADA System

1. Each Automatic Temperature Control System Panel (ATC) shall annunciate critical alarms with Pilot Light (Red) illumination.

2. All critical alarms will also be annunciated to the Facility SCADA system via hard wired contact closure of each respective alarm.

3. All other local Pilot Light indication (Green – System On) (Yellow – System Caution) (Blue – System Off) are considered non-critical and not required to be annunciated to the Facility SCADA System

4. Division 23 - shall provide necessary relays and termination strip for wiring to the Facility SCADA System. Conduit and wiring between the ATC Panel and the SCADA system shall be by Electrical Subcontractor

5. See general sheets for ATC panel and Pilot Light layout.

3.03 GENERAL WORKMANSHIP

A. Install equipment, piping, wiring, and raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.

B. Provide sufficient slack and flexible connections to allow for vibration isolation of piping and equipment.

C. Install all equipment in readily accessible locations as defined by the National Electrical Code (NEC).

D. Verify the integrity of all wiring to ensure continuity and freedom from shorts and grounds.

E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and shall be executed in strict adherence to local codes and standard practices.

3.04 WIRING FOR CONTROL SYSTEMS

A. Furnish and install all wire, conduit, raceways, and cable systems as required for the complete operation of the Building Management and Control System in accordance with the requirements of Section 26 05 19 – Wire and Cabling.

3.05 SENSOR INSTALLATION

A. Install sensors in accordance with the manufacturer's recommendations.

B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

D. All wires attached to sensors shall be air-sealed in their raceways or in the wall in order to stop air transmitted from other areas from affecting sensor readings.

E. Averaging Sensors

1. Sensors used in mixing plenums and hot and cold decks shall be of the averaging type.

2. Averaging sensors shall be installed in a serpentine manner vertically across the duct.

3. Support each bend with a capillary clip.

F. Temperature Sensors

1. All pipe-mounted temperature sensors shall be installed in wells.

2. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

G. Pressure Transducers

1. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

2. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels and not on the equipment monitored or on ductwork.

3. Mount transducers in a vibration-free location accessible for service without the need for ladders or special equipment.

4. All air and water differential pressure sensors shall be provided with gauge tees mounted adjacent to the taps, and water gauges shall be provided with shutoff valves installed before the tee.

3.06 ACTUATORS

A. Mount and link control damper actuators according to manufacturer's instructions.

B. To compress seals when spring-return actuators are used on normally closed dampers, the actuator shall be powered to an approximately 5-degree open position, the damper closed manually, and then the linkage tightened.

C. Check the operation of damper/actuator combination in order to confirm that the actuator modulates damper smoothly throughout the stroke to both OPEN and CLOSED positions.

D. Provide all mounting hardware and linkages for the actuator installation.

E. Electric and Electronic Actuators

1. Dampers

a. Actuators shall be direct mounted on the damper shaft or jackshaft unless indicated as a linkage installation.

b. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degrees available for tightening the damper seals.

c. Actuators shall be mounted in accordance with the manufacturer's recommendations.

3.07 CONTROLLERS

A. General

1. Provide a separate controller for each AHU or other HVAC system.

2. A DDC controller may control more than one system provided that all points associated with the system are assigned to the same DDC controller.

3. Control of an AHU or other mechanical equipment item shall not be split between multiple controllers; points used for control loop reset, such as outside air or space temperature, are exempt from this requirement.

B. Building Controllers and Custom Application Controllers

1. Building controllers and custom application controllers shall be selected to provide a minimum of 15 percent spare I/O point capacity for each point type found at each location.

2. If input points are not universal, 15 percent of each type shall be required, and if outputs are not universal, 15 percent of each type is required.

3. A minimum of one spare is required for each type of point used.

4. The future use of spare capacity shall require providing the field device, field wiring, point database definition, and custom software.

5. No additional controller boards or point modules shall be required to implement use of such spare points.

3.08 PROGRAMMING

A. Provide sufficient internal memory for the specified sequences of operation and trend logging.

B. Provide a minimum of 25 percent of available memory free for future use.

C. BACnet Points

1. Provide a detailed BACnet points list.

2. In addition to standard, I/O information, the BACnet points list shall contain the proposed I/O names and BACnet object description.

3. The proposed I/O names and object descriptions are subject to change as directed by the Engineer.

4. Deliver an as-built list of the BACnet points with actual names and BACnet object addresses to the Owner at Project completion.

D. Software Programming

1. Provide programming for the system and adhere to the indicated sequences of operation.

2. Provide all other system programming necessary for the operation of the system but not indicated in this Section.

3. Embed into the control program sufficient comment statements to clearly describe each section of the program, reflecting the language used in the sequences of operation.

3.09 CONTROL SYSTEM CHECKOUT AND TESTING

A. Start-up Testing

1. All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system.

2. This testing shall be completed before the Engineer is notified of the system demonstration.

B. Furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this Section.

C. Verify that all control wiring is properly connected, free of shorts and ground faults, and that terminations are tight.

D. Enable the control systems and verify calibration of all input devices individually.

E. Perform calibration procedures according to manufacturers' recommendations.

F. Verify that all binary output devices (e.g., relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.

G. Verify that all analog output devices (e.g., I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct.

H. Control Valves

1. Check all control valves and automatic dampers in order to ensure proper action and closure.

2. Make any necessary adjustments to valve stem and damper blade travel.

I. Verify that the system operation adheres to the sequences of operation.

J. Simulate and observe all modes of operation by overriding and varying inputs and schedules.

K. Tune all PID loops and optimize START/STOP routines.

L. Alarms and Interlocks

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

3.10 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration

1. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this Section.

2. These tests shall occur after the Contractor has completed the installation, started up the system, and performed tests.

3.11 TRAINING

A. Provide a minimum of 2 on-site training sessions of 4 hours each, throughout the Contract period for personnel designated by the Owner.

B. Additional Training

1. Provide 2 additional training sessions at 6 and 12 months following the facility's turnover.

2. Each session to be 4 hours in length and shall be coordinated with the Owner.

C. Train the designated Owner's staff to perform the following items:

1. Day-to-day Operations:

a. Operate the system proficiently

b. Understand the control system architecture and configuration

c. Understand the DDC system components

d. Understand system operation, including DDC system control and optimizing routines (algorithms)

e. Operate the workstation and peripherals

f. Log on and off the system

g. Access graphics, point reports, and logs

h. Adjust and change system set points, time schedules, and holiday schedules

i. Recognize malfunctions of the system by observation of the system graphics, trend logs, and other system tools

j. Understand system drawings and the operation and maintenance manual

k. Understand the job layout and location of control components

l. Access data from the DDC controllers and ASCs

m. Operate portable operator terminals

2. Advanced Operations:

a. Create, delete, and modify alarms, including annunciation and routing of these items

b. Create, delete, and modify trend and graph or print these both on ad-hoc basis and at user-definable time intervals

c. Create, delete, and modify reports

d. Add, remove, and modify the system's physical points

e. Create, modify, and delete programming

f. Add panels when required

g. Add operator interface stations

h. Create, delete, and modify system displays, both graphical and others

i. Perform DDC system field checkout procedures

j. Perform DDC controller unit operation and maintenance procedures

k. Configure hardware including controllers and I/O points

l. Maintain, calibrate, and replace system components

3. System Management and Administration:

a. Maintain software and prepare backups

b. Interface with job-specific, third-party operator software

c. Add new users and understand password security procedures

D. Groupings

1. Split the above objectives into 3 logical groupings, as follows and based on the above descriptions.

2. Participants may attend one or more of these, depending on their level of knowledge required.

a. Day-to-day operators

b. Advanced operators

c. System managers and administrators

E. Provide a course outline and materials in accordance with the “Submittals” article in Part 1 of this Section.

F. The instructor shall provide one copy of training material per student

G. The instructor shall be factory-trained and experienced in presenting this material.

H. Classroom training shall be performed using a network of working controllers’ representative of the installed hardware.

END OF SECTION

SECTION 23 23 00– REFRIGERATION PIPING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide copper tube for refrigeration service, complete and in place, as indicated in accordance with the Contract Documents

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 17	Structural Design, Support, and Anchorage
07 92 13	Elastomeric Joint Sealants

C. Reference Standards

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)	
AHRI 710 (2009)	Performance Rating of Liquid-Line Driers
AHRI 711 (2009)	Performance Rating of Liquid-Line Driers
AHRI 720 (2002)	Refrigerant Access Valves and Hose Connectors
ANSI/AHRI 750 (2007)	Thermostatic Refrigerant Expansion Valves
ANSI/AHRI 760 (2007)	Performance Rating of Solenoid Valves for Use With Volatile Refrigerants
AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE)	
ASHRAE 17 (2008)	Method of Testing Capacity of Thermostatic Refrigerant Expansion Valves
AMERICAN WELDING SOCIETY AWS A5.8/A5.8M (2011)	Specification for Filler Metals for Brazing and Braze Welding, AWS BRH (2007; 5th Ed) Brazing Handbook, AWS D1.1/D1.1M (2010) Structural Welding Code – Steel, AWS Z49.1 (2005) Safety in Welding and Cutting and Allied Processes
ASME INTERNATIONAL (ASME)	
ASME B1.20.1 (1983; R 2006)	Pipe Threads, General Purpose
ASME B16.11 (2009)	Forged Fittings, Socket-Welding and Threaded
ASME B16.21 (2011)	Nonmetallic Flat Gaskets for Pipe Flanges
ASME B16.22 (2001; R 2010)	Standard for Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

ASME B16.26 (2011)	Standard for Cast Copper Alloy Fittings for Flared Copper Tubes
ASME B16.3 (2011)	Malleable Iron Threaded Fittings, Classes 150 and 300
ASME B16.5 (2009)	Pipe Flanges and Flanged Fittings: NPS 1/2 Through NPS 24 Inch Standard
ASME B16.9 (2007)	Standard for Factory-Made Wrought Steel Buttwelding Fittings
ASME B31.1 (2010)	Power Piping
ASME B31.5 (2010)	Refrigeration Piping and Heat Transfer Components
ASME B31.9 (2011)	Building Services Piping
ASME B40.100 (2005; R 2010)	Pressure Gauges and Gauge Attachments
ASME BPVC SEC IX (2010)	BPVC Section IX-Welding and Brazing Qualifications
ASTM INTERNATIONAL (ASTM)	
ASTM A193/A193M (2011)	Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A334/A334M (2004a; R 2010)	Standard Specification for Seamless and Welded Carbon and Alloy-Steel Tubes for Low-Temperature Service
ASTM A53/A53M (2010)	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A653/A653M (2011)	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM B117 (2011)	Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM B280 (2008)	Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service
ASTM B32 (2008)	Standard Specification for Solder Metal
ASTM B62 (2009)	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B75 (2002; R 2010)	Standard Specification for Seamless Copper Tube
ASTM B813 (2010)	Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube
ASTM D3308 (2006)	PTFE Resin Skived Tape
ASTM D520 (2000; R 2011)	Zinc Dust Pigment
ASTM E84 (2011b)	Standard Test Method for Surface Burning Characteristics of Building Materials
CSA B52	Mechanical Refrigeration Code

1.03 QUALITY ASSURANCE

A. Submit 4 copies of qualified procedures, and list of names and identification symbols of qualified welders and welding operators, prior to non-factory welding operations. Piping shall be welded in accordance with the qualified procedures using performance

qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPVC SEC IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. Notify the Contracting Officer 24 hours in advance of tests to be performed at the work site, if practical. The welder or welding operator shall apply the personally assigned symbol near each weld made, as a permanent record.

B. Contract Drawings: Because of the small scale of the drawings, it is not possible to indicate all offsets, fittings, and accessories that may be required. Carefully investigate the plumbing, fire protection, electrical, structural and finish conditions that would affect the work to be performed and arrange such work accordingly, furnishing required offsets, fittings, and accessories to meet such conditions.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Proper protection and care of all material both before and during installation is the Contractor's responsibility. Replace any materials found to be damaged at the Contractor's expense. During installation, cap piping and similar openings to keep out dirt and other foreign matter.

PART 2 -- PRODUCTS

2.01 REFRIGERANT PIPING SYSTEM

A. Refrigerant piping, valves, fittings, and accessories shall be in accordance with ANSI/ASHRAE 15 & 34 and ASME B31.5, except as specified herein. Refrigerant piping, valves, fittings, and accessories shall be compatible with the fluids used and capable of withstanding the pressures and temperatures of the service. Refrigerant piping, valves, and accessories used for refrigerant service shall be cleaned, dehydrated, and sealed (capped or plugged) prior to shipment from the manufacturer's plant. Submit drawings, at least 2 weeks prior to beginning construction, provided in adequate detail to demonstrate compliance with contract requirements. Drawings shall consist of:

1. Piping layouts which identify all valves and fittings.

2. Plans and elevations which identify clearances required for maintenance and operation.

2.02 PIPE, FITTINGS AND END CONNECTIONS (JOINTS)

A. Copper Tubing

1. Copper tubing shall conform to ASTM B280 annealed or hard drawn as required.

2. Copper tubing shall be soft annealed where bending is required and hard drawn where no bending is required.

3. Soft annealed copper tubing shall not be used in sizes larger than 1 3/8-in. Joints shall be brazed except that joint on lines 7/8-in and smaller may be flared. Cast copper alloy fittings for flared copper tube shall conform to ASME B16.26 and ASTM B62.

4. Wrought copper and bronze solder-joint pressure fittings shall conform to ASME B16.22 and ASTM B75M ASTM B75. Joints and fittings for brazed joint shall be wrought-copper or forged-brass sweat fittings.

5. Cast sweat-type joints and fittings shall not be allowed for brazed joints. Brass or bronze adapters for brazed tubing may be used for connecting tubing to flanges and to threaded ends of valves and equipment.

B. Solder

1. Solder shall conform to ASTM B32, grade Sb5, tin-antimony alloy for service pressures up to 150 psig. Solder flux shall be liquid or paste form, non-corrosive and conform to ASTM B813.

C. Brazing Filler Metal

1. Filler metal shall conform to AWS A5.8/A5.8M, Type BAg-5 with AWS Type 3 flux, except Type BCuP-5 or BCuP-6 may be used for brazing copper-to-copper joints.

2.03 VALVES

A. Valves, General

1. Valves shall be designed, manufactured, and tested specifically for refrigerant service. Valve bodies shall be of brass, bronze, steel, or ductile iron construction. Valves 1-in and smaller shall have brazed or socket welded connections. Valves larger than 1-in shall have butt welded end connections.

2. Threaded end connections shall not be used, except in pilot pressure or gauge lines where maintenance disassembly is required and welded flanges cannot be used. Internal parts shall be removable for inspection or replacement without applying heat or breaking pipe connections.

3. Valve stems exposed to the atmosphere shall be stainless steel or corrosion resistant metal plated carbon steel. Direction of flow shall be legibly and permanently indicated on the valve body.

4. Control valve inlets shall be fitted with integral or adapted strainer or filter where recommended or required by the manufacturer. Purge, charge and receiver valves shall be of manufacturer's standard configuration.

B. Refrigerant Stop Valves

1. Valve shall be the globe or full-port ball type with a back-seating stem especially packed for refrigerant service. Valve packing shall be replaceable under line

pressure. Valve shall be provided with a handwheel operator, and a seal cap. Valve shall be the straight or angle pattern design as indicated.

C. Check Valves

1. Valve shall be the swing or lift type as required to provide positive shutoff at the differential pressure indicated. Valve shall be provided with resilient seal.

D. Liquid Solenoid Valves

1. Valves shall comply with ANSI/AHRI 760 and be suitable for continuous duty with applied voltages 15 percent under and 5 percent over nominal rated voltage at maximum and minimum encountered pressure and temperature service conditions.

2. Valves shall be direct-acting or pilot-operating type, packless, except that packed stem, seal capped, manual lifting provisions shall be furnished. Solenoid coils shall be moisture-proof, UL approved, totally encapsulated or encapsulated and metal jacketed as required.

3. Valves shall have safe working pressure of 400 psi and a maximum operating pressure differential of at least 200 psi at 85 percent rated voltage. Valves shall have an operating pressure differential suitable for the refrigerant used.

E. Expansion Valves

1. Valve shall conform to ANSI/AHRI 750 and ASHRAE 17. Valve shall be the diaphragm and spring-loaded type with internal or external equalizers, and bulb and capillary tubing.

2. Valve shall be provided with an external superheat adjustment along with a seal cap. Internal equalizers may be utilized where flowing refrigerant pressure drop between outlet of the valve and inlet to the evaporator coil is negligible and pressure drop across the evaporator is less than the pressure difference corresponding to 2 deg F of saturated suction temperature at evaporator conditions. Bulb charge shall be determined by the manufacturer for the application and such that liquid will remain in the bulb at all operating conditions. Gas limited liquid charged valves and other valve devices for limiting evaporator pressure shall not be used without a distributor or discharge tube or effective means to prevent loss of control when bulb becomes warmer than valve body.

3. Pilot-operated valves shall have a characterized plug to provide required modulating control. A de-energized solenoid valve may be used in the pilot line to close the main valve in lieu of a solenoid valve in the main liquid line. An isolatable pressure gauge shall be provided in the pilot line, at the main valve.

4. Automatic pressure reducing or constant pressure regulating expansion valves may be used only where indicted or for constant evaporator loads.

F. Safety Relief Valves

1. Valve shall be the two-way type, unless indicated otherwise.

2. Valve shall bear the ASME code symbol. Valve capacity shall be certified by the National Board of Boiler and Pressure Vessel Inspectors. Valve shall be of an automatically reseating design after activation.

G. Evaporator Pressure Regulators, Direct Acting

1. Valve shall include a diaphragm/spring assembly, external pressure adjustment with seal cap, and pressure gauge port. Valve shall maintain a constant inlet pressure by balancing inlet pressure on diaphragm against an adjustable spring load. Pressure drop at system design load shall not exceed the pressure difference corresponding to a 2 deg F change in saturated refrigerant temperature at evaporator operating suction temperature. Spring shall be selected for indicated maximum allowable suction pressure range.

H. Refrigerant Access Valves

1. Refrigerant access valves and hose connections shall be in accordance with AHRI 720.

2.04 PIPING ACCESSORIES

A. Filter Driers

1. Driers shall conform to AHRI 711AHRI 710. Sizes 5/8-in and larger shall be the full flow, replaceable core type. Sizes ½-in and smaller shall be the sealed type. Cores shall be of suitable desiccant that will not plug, cake, dust, channel, or break down, and shall remove water, acid, and foreign material from the refrigerant.

2. Filter driers shall be constructed so that none of the desiccant will pass into the refrigerant lines. Minimum bursting pressure shall be 1,500 psi.

B. Sight Glass and Liquid Level Indicator

1. Assembly and Components: Assembly shall be pressure- and temperature-rated and constructed of materials suitable for the service. Glass shall be borosilicate type.

2. Ferrous components subject to condensation shall be electro-galvanized.

C. Gauge Glass

1. Gauge glass shall include top and bottom isolation valves fitted with automatic checks, and packing followers; red-line or green-line gauge glass; elastomer or polymer packing to suit the service; and gauge glass guard.

D. Bull's-Eye and Inline Sight Glass Reflex Lens

1. Bull's-eye and inline sight glass reflex lens shall be provided for dead-end liquid service. For pipeline mounting, two plain lenses in one body suitable for backlighted viewing shall be provided.

E. Moisture Indicator

1. Indicator shall be a self-reversible action, moisture reactive, color changing media. Indicator shall be furnished with full-color-printing tag containing color, moisture and temperature criteria. Unless otherwise indicated, the moisture indicator shall be an integral part of each corresponding sight glass.

F. Vibration Dampeners

1. Dampeners shall be of the all-metallic bellows and woven-wire type.

G. Flexible Pipe Connectors

1. Connector shall be a composite of interior corrugated phosphor bronze or Type 300 Series stainless steel, as required for fluid service, with exterior reinforcement of bronze, stainless steel or monel wire braid. Assembly shall be constructed with a safety factor of not less than 4 at 300 deg F. Unless otherwise indicated, the length of a flexible connector shall be as recommended by the manufacturer for the service intended.

H. Strainers

1. Strainers used in refrigerant service shall have brass or cast-iron body, Y-or angle-pattern, cleanable, not less than 60-mesh noncorroding screen of an area to provide net free area not less than ten times the pipe diameter with pressure rating compatible with the refrigerant service. Screens shall be stainless steel or monel and reinforced spring-loaded where necessary for bypass-proof construction.

I. Pressure and Vacuum Gauges

1. Gauges shall conform to ASME B40.100 and shall be provided with throttling type needle valve or a pulsation dampener and shut-off valve. Gauge shall be a minimum of 3 ½-in in diameter with a range from 0 psig to approximately 1.5 times the maximum system working pressure. Each gauge range shall be selected so that at normal operating pressure, the needle is within the middle-third of the range

J. Temperature Gauges

1. Temperature gauges shall be the industrial duty type and be provided for the required temperature range. Gauges shall have Fahrenheit scale in 2 degrees graduations scale (black numbers) on a white face. The pointer shall be adjustable. Rigid stem type temperature gauges shall be provided in thermal wells located within 5 ft of the finished floor. Universal adjustable angle type or remote element type temperature gauges shall be provided in thermal wells located 5 ft to 7 ft above the finished floor. Remote element type temperature gauges shall be provided in thermal wells located 7 ft above the finished floor.

K. Stem Cased-Glass

1. Stem cased-glass case shall be polished stainless steel or cast aluminum, 9-in long, with clear acrylic lens, and non-mercury filled glass tube with indicating-fluid column.

L. Bimetallic Dial

1. Bimetallic dial type case shall be not less than 3 ½-in, stainless steel, and shall be hermetically sealed with clear acrylic lens.

2. Bimetallic element shall be silicone dampened, and unit fitted with external calibrator adjustment. Accuracy shall be one percent of dial range.

M. Liquid-, Solid-, and Vapor-Filled Dial

1. Liquid-, solid-, and vapor-filled dial type cases shall be not less than 3 ½-in , stainless steel or cast aluminum with clear acrylic lens.

2. Fill shall be nonmercury, suitable for encountered cross-ambients, and connecting capillary tubing shall be double-braided bronze.

N. Thermal Well

1. Thermal well shall be identical size, ½-in or ¾-in NPT connection, brass or stainless steel. Where test wells are indicated, provide captive plug-fitted type ½-in NPT connection suitable for use with either engraved stem or standard separable socket thermometer or thermostat. Mercury shall not be used in thermometers. Extended neck thermal wells shall be of sufficient length to clear insulation thickness by 1-in.

O. Pipe Hangers, Inserts, and Supports

1. Pipe hangers, inserts, guides, and supports shall conform to MSS SP-58 and MSS SP-69.

P. Escutcheons

1. Escutcheons shall be chromium-plated iron or chromium-plated brass, either one piece or split pattern, held in place by internal spring tension or set screws.

2.05 FABRICATION

A. Factory Coating

1. Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, shall be factory finished with the manufacturer's standard finish, except that items located outside of buildings shall have weather resistant finishes that will withstand [125] [500] hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution. Immediately after completion of the test, the specimen shall show no signs of blistering, wrinkling,

cracking, or loss of adhesion and no sign of rust creepage beyond 1/8-in on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used shall be coated with a zinc-rich coating conforming to ASTM D520, Type I.

B. Refrigerant Pipe Insulation

1. Insulation shall be a flexible, closed-cell elastomeric pipe insulation, AP Armaflex, AC Accoflex.

2. Adhesive shall be Armaflex 520, 520 Black or 520 BLV Adhesive. The insulation must conform to ASTM C534 Grade 1, Type I.

3. Insulation materials shall have a closed cell structure to prevent moisture from wicking which makes it an efficient insulation.

4. Insulation materials shall be manufactured without the use of CFC's, HFC's or HCFC's. It is also formaldehyde free, low VOCs, fiber free, dust free and resists mold and mildew.

5. Insulation materials shall have a flame-spread index of less than 25 and a smoke-developed index of less than 50 as tested in accordance with ASTM E 84. In addition, the products, when tested, shall not melt or drip flaming particles, and the flame shall not be progressive.

6. Insulation materials shall have a maximum thermal conductivity of 0.27 Btu-in./h-ft^2-deg F at a 75 deg F mean temperature as tested in accordance with ASTM C 177 or ASTM C 518.

7. Insulation materials shall have a maximum water vapor transmission of 0.08 perm-in when tested in accordance with ASTM E 96, Procedure A.

8. As a minimum, insulated items installed indoors shall have a flame spread index no higher than 75 and a smoke developed index no higher than 150.

9. Insulated items (no jacket) installed indoors, and which are located in air plenums, in ceiling spaces, and in attic spaces shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50.

10. Flame spread and smoke developed indexes shall be determined by ASTM E84.

11. Insulation shall be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket shall be tested as a composite material.

12. Jackets, facings, and adhesives shall have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

13. All liquid and suction lines shall be insulated continuously from a point 6-in inside the display case to the suction service valve at the compressor.

14. All low temperature lines (plus 10 deg F and below) shall be insulated with a minimum of 1-in wall thickness.

15. All medium and high temperature lines (above plus 10 deg F) shall be insulated with a minimum of ¾-in wall thickness.

16. Heat reclaim lines shall be insulated from the condensing unit to the heat reclaim units with ¾-in thickness.

17. All refrigerant copper lines must be free of extraneous chemicals such as corrosive cleaners or building materials' dust prior to the installation of the insulation. The insulation must be clean and dry prior to installation.

18. Refrigerant pipe shall be sealed while slipping on insulation to prevent foreign matter from entering the tube.

19. Insulation is to be slid onto pipe; longitudinal slitting of the insulation is not allowed except on mitered sections. Insulation shall be pushed onto pipe, not pulled.

20. Insulation shall be mitered, preadhered and longitudinally slit inside throat to fit over all Ptraps, tees and elbows or bends over 90 degrees.

21. All butt joints and mitered seams shall be adhered with full coverage of adhesive on both surfaces. Insulation shall not be stretched when adhering.

22. Insulation must be installed in an adequately ventilated area. It may be necessary to increase insulation thickness if adequate ventilation is not present, Do not crowd the insulation, allow for adequate air movement.

23. At the beginning, at every 12 ft to 18 ft , and at the ends of piping runs, the insulation shall be adhered directly to the copper using a 2-in strip of adhesive. Insulation should not be adhered to the pipe at the extreme low points in any piping run.

24. Saddles shall be installed under all insulated lines at unistrut clamps, clevis hangers, or locations where insulation may be compressed.

25. Armafix IPH or NPH insulation pipe hangers can be installed at the compression locations and the seams shall be sealed with Armaflex 520, 520 Black or 520 BLV contact adhesive.

26. To minimize the movement of Armafix, a pair of non-skid pads be adhered to the clamps. In addition, to prevent loosening of the clamps, use of an anti-vibratory fastener, such as a nylon-locking nut.

27. Wood dowels or blocks, of a thickness equal to the insulation, shall be inserted and must be completely sealed into the insulation at the saddle locations. All seams shall be sealed with Armaflex 520, 520 Black or 520 BLV contact adhesive.

28. Hangers clamped directly to the pipe shall be insulated over the hanger; insulation shall be fully adhered to the hanger. In addition, hangers with double rods shall be

insulated between the rods. All seams of the insulation shall be sealed with adhesive.

29. All insulation exposed to sunlight or installed outdoors shall be protected with two coats of WB Armaflex Finish or weather resistant coating.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. After becoming familiar with all details of the work, perform a verification of dimensions in the field. Submit a letter, at least 2 weeks prior to beginning construction, including the date the site was visited, conformation of existing conditions, and any discrepancies found before performing any work.

3.02 INSTALLATION

A. Install and test in accordance with the Provincial Refrigeration Code and CSA B52.

B. Pipe and fitting installation shall conform to the requirements of ASME B31.1. Pipe shall be cut accurately to measurements established at the jobsite, and worked into place without springing or forcing, completely clearing all windows, doors, and other openings. Cutting or other weakening of the building structure to facilitate piping installation will not be permitted without written approval. Pipe or tubing shall be cut square, shall have burrs removed by reaming, and shall permit free expansion and contraction without causing damage to the building structure, pipe, joints, or hangers.

1. Directional Changes: Changes in direction shall be made with fittings, except that bending of pipe 4-in and smaller will be permitted, provided a pipe bender is used and wide weep bends are formed. Mitering or notching pipe or other similar construction to form elbows or tees will not be permitted. The centerline radius of bends shall not be less than 6 diameters of the pipe. Bent pipe showing kinks, wrinkles, flattening, or other malformations will not be accepted.

2. Functional Requirements: Piping shall be installed ½-in/10 ft of pipe in the direction of flow to ensure adequate oil drainage. Open ends of refrigerant lines or equipment shall be properly capped or plugged during installation to keep moisture, dirt, or other foreign material out of the system. Piping shall remain capped until installation. Equipment piping shall be in accordance with the equipment manufacturer's recommendations and the contract drawings. Equipment and piping arrangements shall fit into space allotted and allow adequate acceptable clearances for installation, replacement, entry, servicing, and maintenance.

C. Fittings and End Connections

1. Threaded Connections: Threaded connections shall be made with tapered threads and made tight with PTFE tape complying with ASTM D3308 or equivalent thread-joint compound applied to the male threads only. Not more than three threads shall show after the joint is made.

D. Brazed Connections

1. Brazing shall be performed in accordance with AWS BRH, except as modified herein. During brazing, the pipe and fittings shall be filled with a pressure regulated inert gas, such as nitrogen, to prevent the formation of scale. Before brazing copper joints, both the outside of the tube and the inside of the fitting shall be cleaned with a wire fitting brush until the entire joint surface is bright and clean. Brazing flux shall not be used. Surplus brazing material shall be removed at all joints. Steel tubing joints shall be made in accordance with the manufacturer's recommendations. Joints in steel tubing shall be painted with the same material as the baked-on coating within 8 hours after joints are made. Tubing shall be protected against oxidation during brazing by continuous purging of the inside of the piping using nitrogen. Piping shall be supported prior to brazing and not be sprung or forced.

E. Welded Connections

1. Welded joints in steel refrigerant piping shall be fusion-welded. Branch connections shall be made with welding tees or forged welding branch outlets. Pipe shall be thoroughly cleaned of all scale and foreign matter before the piping is assembled. During welding the pipe and fittings shall be filled with an inert gas, such as nitrogen, to prevent the formation of scale. Beveling, alignment, heat treatment, and inspection of weld shall conform to ASME B31.1. Weld defects shall be removed and rewelded at no additional cost to the Government. Electrodes shall be stored and dried in accordance with AWS D1.1/D1.1M or as recommended by the manufacturer. Electrodes that have been wetted or that have lost any of their coating shall not be used.

F. Flared Connections

1. When flared connections are used, a suitable lubricant shall be used between the back of the flare and the nut in order to avoid tearing the flare while tightening the nut.

G. Flanged Connections

1. When steel refrigerant piping is used, union or flange joints shall be provided in each line immediately preceding the connection to each piece of equipment requiring maintenance, such as compressors, coils, chillers, control valves, and other similar items. Flanged joints shall be assembled square end tight with matched flanges, gaskets, and bolts. Gaskets shall be suitable for use with the refrigerants to be handled.

H. Valves General

1. Refrigerant stop valves shall be installed on each side of each piece of equipment such as compressors condensers, evaporators, receivers, and other similar items in multiple-unit installation, to provide partial system isolation as required for maintenance or repair. Stop valves shall be installed with stems horizontal unless otherwise indicated. Ball valves shall be installed with stems positioned to facilitate operation and maintenance. Isolating valves for pressure gauges and switches

shall be external to thermal insulation. Safety switches shall not be fitted with isolation valves. Filter dryers having access ports may be considered a point of isolation. Purge valves shall be provided at all points of systems where accumulated non-condensable gases would prevent proper system operation. Valves shall be furnished to match line size, unless otherwise indicated or approved.

I. Expansion Valves

1. Expansion valves shall be installed with the thermostatic expansion valve bulb located on top of the suction line when the suction line is less than 2 1/8-in in diameter and at the 4 o'clock or 8 o'clock position on lines larger than 2 1/8-in. The bulb shall be securely fastened with two clamps. The bulb shall be insulated. The bulb shall be installed in a horizontal portion of the suction line, if possible, with the pigtail on the bottom. If the bulb must be installed in a vertical line, the bulb tubing shall be facing up.

J. Valve Identification

1. Each system valve, including those which are part of a factory assembly, shall be tagged. Tags shall be in alphanumeric sequence, progressing in direction of fluid flow. Tags shall be embossed, engraved, or stamped plastic or nonferrous metal of various shapes, sized approximately 1 3/8-in diameter, or equivalent dimension, substantially attached to a component or immediately adjacent thereto. Tags shall be attached with nonferrous, heavy duty, bead or link chain, 14-gauge annealed wire, nylon cable bands or as approved. Tag numbers shall be referenced in Operation and Maintenance Manuals and system diagrams.

K. Vibration Dampers

1. Vibration damper shall be provided in the suction and discharge lines on spring mounted compressors. Vibration dampers shall be installed parallel with the shaft of the compressor and shall be anchored firmly at the upstream end on the suction line and the downstream end in the discharge line.

L. Strainers

1. Strainers shall be provided immediately ahead of solenoid valves and expansion devices. Strainers may be an integral part of an expansion valve.

M. Filter Dryer

1. A liquid line filter dryer shall be provided on each refrigerant circuit located such that all liquid refrigerant passes through a filter dryer.

2. Dryers shall be sized in accordance with the manufacturer's recommendations for the system in which it is installed.

3. Dryers shall be installed such that it can be isolated from the system, the isolated portion of the system evacuated, and the filter dryer replaced. Dryers shall be

installed in the horizontal position except replaceable core filter dryers may be installed in the vertical position with the access flange on the bottom.

N. Sight Glass

1. A moisture indicating sight glass shall be installed in all refrigerant circuits down stream of all filter dryers and where indicated. Site glasses shall be full line size.

O. Discharge Line Oil Separator

1. Discharge line oil separator shall be provided in the discharge line from each compressor. Oil return line shall be connected to the compressor as recommended by the compressor manufacturer.

P. Accumulator

1. Accumulators shall be provided in the suction line to each compressor.

Q. Flexible Pipe Connectors

1. Connectors shall be installed perpendicular to line of motion being isolated. Piping for equipment with bidirectional motion shall be fitted with two flexible connectors, in perpendicular planes. Reinforced elastomer flexible connectors shall be installed in accordance with manufacturer's instructions. Piping guides and restraints related to flexible connectors shall be provided as required.

R. Temperature Gauges

1. Temperature gauges shall be located specifically on, but not limited to the following: the liquid line leaving a receiver and the suction line at each evaporator or liquid cooler. Thermal wells for insertion thermometers and thermostats shall extend beyond thermal insulation surface not less than 1-in.

S. Pipe Hangers, Inserts, and Supports

1. Pipe hangers, inserts, and supports shall conform to MSS SP-58 and MSS SP-69, except as modified herein. Pipe hanger types 5, 12, and 26 shall not be used. Hangers used to support piping 2-in and larger shall be fabricated to permit adequate adjustment after erection while still supporting the load. Piping subjected to vertical movement, when operating temperatures exceed ambient temperatures, shall be supported by variable spring hangers and supports or by constant support hangers.

T. Hangers

1. Type 3 shall not be used on insulated piping. Type 24 may be used only on trapeze hanger systems or on fabricated frames.

U. Inserts

1. Type 18 inserts shall be secured to concrete forms before concrete is placed. Continuous inserts which allow more adjustments may be used if they otherwise meet the requirements for Type 18 inserts.

V. C-Clamps

1. Type 19 and 23 C-clamps shall be torqued in accordance with MSS SP-69 and have both locknuts and retaining devices, furnished by the manufacturer.

2. Field-fabricated C-clamp bodies or retaining devices are not acceptable.

W. Angle Attachments

1. Type 20 attachments used on angles and channels shall be furnished with an added malleable-iron heel plate or adapter.

X. Saddles and Shields

1. Where Type 39 saddle or Type 40 shield are permitted for a particular pipe attachment application, the Type 39 saddle, connected to the pipe, shall be used on all pipe 4-in and larger when the temperature of the medium is 60 deg F or higher. Type 40 shields shall be used on all piping less than 4-in and all piping 4-in and larger carrying medium less than 60 deg F. A high-density insulation insert of cellular glass shall be used under the Type 40 shield for piping 2-in and larger.

Y. Horizontal Pipe Supports

1. Horizontal pipe supports shall be spaced as specified in MSS SP-69 and a support shall be installed not over 1 ft from the pipe fitting joint at each change in direction of the piping. Pipe supports shall be spaced not over 5 ft apart at valves. Pipe hanger loads suspended from steel joist with hanger loads between panel points in excess of 50 pounds shall have the excess hanger loads suspended from panel points.

Z. Vertical Pipe Supports

1. Vertical pipe shall be supported at each floor, except at slab-on-grade, and at intervals of not more than 15 ft not more than 28 ft from end of risers, and at vent terminations.

AA. Pipe Guides

1. Type 35 guides using, steel, reinforced polytetrafluoroethylene (PTFE) or graphite slides shall be provided where required to allow longitudinal pipe movement. Lateral restraints shall be provided as required. Slide materials shall be suitable for the system operating temperatures, atmospheric conditions, and bearing loads encountered.

BB. Steel Slides

1. Where steel slides do not require provisions for restraint of lateral movement, an alternate guide method may be used. On piping 4-in and larger, a Type 39 saddle shall be used. On piping under 4-in, a Type 40 protection shield may be attached to the pipe or insulation and freely rest on a steel slide plate.

CC. High Temperature Guides with Cradles

1. Where there are high system temperatures and welding to piping is not desirable, then the Type 35 guide shall include a pipe cradle, welded to the guide structure and strapped securely to the pipe. The pipe shall be separated from the slide material by at least 4-in, or by an amount adequate for the insulation, whichever is greater.

DD. Multiple Pipe Runs

1. In the support of multiple pipes runs on a common base member, a clip or clamp shall be used where each pipe crosses the base support member.

2. Spacing of the base support members shall not exceed the hanger and support spacing required for an individual pipe in the multiple pipes run.

EE. Structural Attachments

1. Attachment to building structure concrete and masonry shall be by cast-in concrete inserts, built-in anchors, or masonry anchor devices. Inserts and anchors shall be applied with a safety factor not less than 5. Supports shall not be attached to metal decking.

2. Masonry anchors for overhead applications shall be constructed of ferrous materials only.

3. Structural steel brackets required to support piping, headers, and equipment, but not shown, shall be provided under this section.

FF. Seismic Requirements

1. Piping and attached valves shall be supported and braced to resist seismic loads as specified under 01 33 17 - Structural Design, Support, and Anchorage.

2. Comply with spec Section 01 33 17 – Structural Design, Support, and Anchorage

GG. Pipe Alignment Guides

1. Pipe alignment guides shall be provided where indicated for expansion loops, offsets, and bends and as recommended by the manufacturer for expansion joints, not to exceed 5 ft on each side of each expansion joint, and in lines 4-in or smaller not more than 2 ft on each side of the joint.

HH. Pipe Anchors

1. Anchors shall be provided wherever necessary or indicated to localize expansion or to prevent undue strain on piping. Anchors shall consist of heavy steel collars

with lugs and bolts for clamping and attaching anchor braces, unless otherwise indicated. Anchor braces shall be installed in the most effective manner to secure the desired results using turnbuckles where required. Supports, anchors, or stays shall not be attached where they will injure the structure or adjacent construction during installation or by the weight of expansion of the pipeline. Where pipe and conduit penetrations of vapor barrier sealed surfaces occur, these items shall be anchored immediately adjacent to each penetrated surface, to provide essentially zero movement within penetration seal. Detailed drawings of pipe anchors shall be submitted for approval before installation.

II. Building Surface Penetrations

1. Sleeves shall not be installed in structural members except where indicated or approved. Sleeves in non-load bearing surfaces shall be galvanized sheet metal, conforming to ASTM A653/A653M, Coating Class G-90, 20 gauge. Sleeves in load bearing surfaces shall be uncoated carbon steel pipe, conforming to ASTM A53/A53M, Schedule 30. Sealants shall be applied to moisture and oil-free surfaces and elastomers to not less than ½-in depth. Sleeves shall not be installed in structural members.

JJ. Refrigerated Space

1. Refrigerated space building surface penetrations shall be fitted with sleeves fabricated from hand-lay-up or helically wound, fibrous glass reinforced polyester or epoxy resin with a minimum thickness equal to equivalent size Schedule 40 steel pipe. Sleeves shall be constructed with integral collar or cold side shall be fitted with a bonded slip-on flange or extended collar. In the case of masonry penetrations where sleeve is not cast-in, voids shall be filled with latex mixed mortar cast to shape of sleeve and flange/external collar type sleeve shall be assembled with butyl elastomer vapor barrier sealant through penetration to cold side surface vapor barrier overlap and fastened to surface with masonry anchors. Integral cast-in collar type sleeve shall be flashed with not less than 4-in of cold side vapor barrier overlap of sleeve surface. Normally non insulated penetrating round surfaces shall be sealed to sleeve bore with mechanically expandable seals in vapor tight manner and remaining warm and cold side sleeve depth shall be insulated with not less than 4-in of foamed-in-place rigid polyurethane or foamed-in-place silicone elastomer. Vapor barrier sealant shall be applied to finish warm side insulation surface. Warm side of penetrating surface shall be insulated beyond vapor barrier sealed sleeve insulation for a distance which prevents condensation. Wires in refrigerated space surface penetrating conduit shall be sealed with vapor barrier plugs or compound to prevent moisture migration through conduit and condensation therein.

KK. General Service Areas

1. Each sleeve shall extend through its respective wall, floor, or roof, and shall be cut flush with each surface. Pipes passing through concrete or masonry wall or concrete floors or roofs shall be provided with pipe sleeves fitted into place at the time of construction. Sleeves shall be of such size as to provide a minimum of ¼-in all-around clearance between bare pipe and sleeves or between jacketed-insulation and sleeves.

2. Except in pipe chases or interior walls, the annular space between pipe and sleeve or between jacket over-insulation and sleeve shall be sealed in accordance with Section 07 92 13 - Elastomeric Joint Sealants.

LL. Waterproof Penetrations

1. Pipes passing through roof or floor waterproofing membrane shall be installed through a 17 oz copper sleeve, or a 0.032-in thick aluminum sleeve, each within an integral skirt or flange.

2. Flashing sleeve shall be suitably formed, and skirt or flange shall extend not less than 8-in from the pipe and be set over the roof of floor membrane in a troweled coating of bituminous cement. The flashing sleeve shall extend up the pipe a minimum of 2-in above the roof or floor penetration. The annular space between the flashing sleeve and the bare pipe or between the flashing sleeve and the metal-jacket-covered insulation shall be sealed as indicated. Penetrations shall be sealed by either one of the following methods.

3. Waterproofing Clamping Flange: Pipes up to and including 10-in in diameter passing through roof or floor waterproofing membrane may be installed through a cast iron sleeve with caulking recess, anchor lugs, flashing clamp device, and pressure ring with brass bolts. Waterproofing membrane shall be clamped into place and sealant shall be placed in the caulking recess.

4. Modular Mechanical Type Sealing Assembly: In lieu of a waterproofing clamping flange and caulking and sealing of annular space between pipe and sleeve or conduit and sleeve, a modular mechanical type sealing assembly may be installed. Seals shall consist of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe/conduit and sleeve with corrosion protected carbon steel bolts, nuts, and pressure plates. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and each nut. After the seal assembly is properly positioned in the sleeve, tightening of the bolt shall cause the rubber sealing elements to expand and provide a watertight seal rubber sealing elements to expand and provide a watertight seal between the pipe/conduit seal between the pipe/conduit and the sleeve. Each seal assembly shall be sized as recommended by the manufacturer to fit the pipe/conduit and sleeve involved. The Contractor electing to use the modular mechanical type seals shall provide sleeves of the proper diameters.

MM. Escutcheons

1. Finished surfaces where exposed piping, bare or insulated, pass through floors, walls, or ceilings, except in boiler, utility, or equipment rooms, shall be provided with escutcheons. Where sleeves project slightly from floors, special deep-type escutcheons shall be used. Escutcheon shall be secured to pipe or pipe covering.

NN. Access Panels

1. Access panels shall be provided for all concealed valves, vents, controls, and items requiring inspection or maintenance. Access panels shall be of sufficient size

and located so that the concealed items may be serviced and maintained or completely removed and replaced.

OO. Identification Tags

1. Provide identification tags made of brass, engraved laminated plastic or engraved anodized aluminum indicating service and item number on all valves and dampers. Tags shall be 1 3/8-in minimum diameter and marking shall be stamped or engraved. Indentations shall be black for reading clarity. Tags shall be attached to valves with No. 12 AWG copper wire, chrome-plated beaded chain or plastic straps designed for that purpose.

3.03 CLEANING AND ADJUSTING

A. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture contaminated refrigerant, or any foreign matter shall be considered contaminated systems. Restoring contaminated systems to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging, shall be performed using currently approved refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government as determined by the Contracting Officer. Water shall not be used in any procedure or test.

3.04 REFRIGERANT PIPING TESTS

A. General

1. After all components of the refrigerant system have been installed and connected, subject the entire refrigeration system to pneumatic, evacuation, and startup tests as described herein. Submit a schedule, at least 2 weeks prior to the start of related testing, for each test. Identify the proposed date, time, and location for each test. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test. Provide the services of a qualified technician, as required, to perform all tests and procedures indicated herein.

2. SYSTEMS. Submit 6 copies of the tests report in bound 8 1/2 by 11-in booklets documenting all phases of the tests performed. The report shall include initial test summaries, all repairs/adjustments made, and the final test results.

B. Preliminary Procedures

1. Prior to pneumatic testing, equipment which has been factory tested, and refrigerant charged as well as equipment which could be damaged or cause personnel injury by imposed test pressure, positive or negative, shall be isolated from the test pressure or removed from the system. Safety relief valves and rupture discs, where not part of factory sealed systems, shall be removed and openings capped or plugged.

C. Pneumatic Test

1. Pressure control and excess pressure protection shall be provided at the source of test pressure. Valves shall be wide open, except those leading to the atmosphere. Test gas shall be dry nitrogen, with minus minus 70 deg F dewpoint and less than 5 ppm oil. Test pressure shall be applied in two stages before any refrigerant pipe is insulated or covered. First stage test shall be at 10 psi with every joint being tested with a thick soap or color indicating solution. Second stage tests shall raise the system to the minimum refrigerant leakage test pressure specified in ANSI/ASHRAE 15 & 34 with a maximum test pressure 25 percent greater. Pressure above 100 psig shall be raised in 10 percent increments with a pressure acclimatizing period between increments. The initial test pressure shall be recorded along with the ambient temperature to which the system is exposed. Final test pressures of the second stage shall be maintained on the system for a minimum of 24 hours. At the end of the 24-hour period, the system pressure will be recorded along with the ambient temperature to which the system is exposed. A correction factor of 0.3 psi will be allowed for each degree F change between test space initial and final ambient temperature, plus for increase and minus for a decrease. If the corrected system pressure is not exactly equal to the initial system test pressure, then the system shall be investigated for leaking joints. To repair leaks, the joint shall be taken apart, thoroughly cleaned, and reconstructed as a new joint. Joints repaired by caulking, remelting, or back-welding/brazing shall not be acceptable. Following repair, the entire system shall be retested using the pneumatic tests described above. The entire system shall be reassembled once the pneumatic tests are satisfactorily completed.

D. Evacuation Test

1. Following satisfactory completion of the pneumatic tests, the pressure shall be relieved, and the entire system shall be evacuated to an absolute pressure of 0.012-in. During evacuation of the system, the ambient temperature shall be higher than 35 deg F. No more than one system shall be evacuated at one time by one vacuum pump. Once the desired vacuum has been reached, the vacuum line shall be closed, and the system shall stand for 1 hour. If the pressure rises over 0.020-in after the 1-hour period, then the system shall be evacuated again down to 0.012-in and let set for another 1-hour period. The system shall not be charged until a vacuum of at least 0.020-in is maintained for a period of 1 hour without the assistance of a vacuum line. If during the testing the pressure continues to rise, check the system for leaks, repair as required, and repeat the evacuation procedure. During evacuation, pressures shall be recorded by a thermocouple-type, electronic-type, or a calibrated-micrometer type gauge.

E. System Charging and Startup Test

1. Following satisfactory completion of the evacuation tests, the system shall be charged with the required amount of refrigerant by raising pressure to normal operating pressure and in accordance with manufacturer's procedures. Following charging, the system shall operate with high-side and low-side pressures and corresponding refrigerant temperatures, at design or improved values. The entire system shall be tested for leaks. Fluorocarbon systems shall be tested with halide torch or electronic leak detectors.

F. Refrigerant Leakage

1. If a refrigerant leak is discovered after the system has been charged, the leaking portion of the system shall immediately be isolated from the remainder of the system and the refrigerant pumped into the system receiver or other suitable container. Under no circumstances shall the refrigerant be discharged into the atmosphere.

G. Contractor's Responsibility

1. At all times during the installation and testing of the refrigeration system, take steps to prevent the release of refrigerants into the atmosphere. The steps shall include, but not be limited to, procedures which will minimize the release of refrigerants to the atmosphere and the use of refrigerant recovery devices to remove refrigerant from the system and store the refrigerant for reuse or reclaim. At no time shall more than 3 ounces of refrigerant be released to the atmosphere in any one occurrence. Any system leaks within the first year shall be repaired in accordance with the requirements herein at no cost to the Government including material, labor, and refrigerant if the leak is the result of defective equipment, material, or installation.

END OF SECTION

SECTION 23 31 13 – METAL DUCTWORK SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide ductwork, complete and operable, as indicated in accordance with the Contract Documents.

B. Furnish design calculations used to determine duct wall thickness and reinforcements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage

C. Reference Standards

Associated Air Balance Council (AABC)	
Air Movement and Control Association International, Inc. (AMCA)	
AMCA 500	Test Methods for Louvers, Dampers, and Shutters
American Society of Civil Engineers (ASCE)	
ASCE 7-10	Minimum Design Loads for Buildings and Other Structures
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASTM International (ASTM)	
ASTM D638	Standard Test Method for Tensile Properties of Plastics
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2310	Standard Classification for Machine-Made “Fiberglass” (Reinforced Thermosetting Resin) Pipe
ASTM D2563	Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts
ASTM D2992	Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

ASTM D2996	Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe
ASTM E84	Standard Test Method for Surface Burning Characteristics of Building Materials
National Fire Protection Association (NFPA)	
NFPA 90A	Standard for the Installation of Air Conditioning and Ventilating Systems
NFPA 90B	Standard for the Installation of Warm Air Heating and Air Conditioning Systems
NFPA 91	Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists and Noncombustible Particulate Solids
Sheet Metal and Air Conditioning Contractors’ National Association (SMACNA)	
SMACNA	Thermoset FRP Duct Construction Manual

D. Codes and Standards, General

1. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2016 IBC Section 1613/ASCE 7-10 Chapter 13, 2020 NBC Section 4.1

2. Perform and provide the Work in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning systems), the local Plumbing Code, the local Building Code, and other local codes.

3. In the absence of applicable codes, follow the installation and workmanship standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

4. Provide the ductwork systems in accordance with the latest edition of the ASHRAE Handbook, SMACNA Manual, and the International Mechanical Code.

5. Where conflict between these standards arises, the most stringent criterion shall control. Ducts shall be listed for use without the necessity for internal fire protection sprinklers or any devices relied on to cut off air flow in the event of fire by Factory Mutual Research Standard 4922.

6. ASHRAE Standards: Comply with AS~E handbook, Equipment Volume, Chapter "Duct Construction," for fabrication and installation of metal duct.

7. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilation Systems," NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems," and NFPA 91 "Standard for the Installation of Blower and Exhaust Systems."

8. Field Reference Manual: Have available for reference at Project field office a copy of SMACNA "Round Industrial Duct Construction Standards."

9. Comply with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal duct, and SMACNA's "Round Industrial Duct Construction Standards" intended for use by designers of industrial ventilation systems.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings:

1. The HVAC design drawings define the general layout, configuration, routing, size, and the general intent of the design and are not fabrication drawings. Contractors shall be responsibility to develop the shop drawings required for the construction of the HVAC system(s).

2. Submit detailed fabrication drawings with layouts and all necessary dimensions and details on equipment, and ductwork. Show all fittings and supports necessary to accommodate the equipment provided in a complete and functional system. Show main and branch runs, fittings, offsets, takeoffs, accessories, supports, anchorage, point loads and seismic restraints, and dimensions of sub-assemblies to be shipped.

3. The ductwork dimensions provided on the design drawings represent a free area and they are clear inside dimensions. The contractor shall be responsible to account for the loss of free area due acoustical lining, or any internal obstructions, and oversize the ductwork to provide the same free area as the one shown on the design drawings.

1.4 QUALITY ASSURANCE

A. Qualifications, General

1. Ductwork shall be fabricated and installed by experienced workers who have experience with fabrication, and installation of ductwork.

2. Work and materials shall be in full accordance with the latest rules and regulations or publications of the State Energy Resources Conservation and Development Commission, the State Fire Marshall, the Industrial Safety Orders, the Health and Safety Rules (Air Conditioning systems), the local Plumbing Code, the local Building Code, and other local codes.

3. Nothing in the Contract Documents shall be construed to permit work in violation of the above codes, rules and regulations.

4. In the absence of applicable codes, the installation and workmanship shall follow the standards set by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE). Use firms regularly engaged in the manufacture of ETFE coated stainless steel duct products of types, materials, and sizes required.

5. The manufacturer shall perform their own sheet metal fabrication and coating processes.

6. Use manufacturers whose ETFE-coated stainless-steel duct shall have been in satisfactory use for not less than 5 years.

7. The Owner shall have the right to tour the manufacturer's plant any time that fabrication is being performed on duct intended for the Project.

8. Installer Qualifications: The installation contractor shall have at least 3 years of successful experience on duct projects, specifically industrial exhaust systems.

B. Inspection and Testing

1. All ductworks shall be inspected and approved by a qualified QC person in order to ensure proper welding and dimensional tolerances. The Inspector shall provide a written approval to the resident engineer or owner, stating that the ductwork has been inspected and is free of any defects.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General

1. Duct, fittings, and dampers shall be protected from damage and shall be supported by minimum 4-in wide strapping to avoid damage due to flex strains and point loading during shipping and installation.

2. Debris and other extraneous material shall not be allowed to enter the duct.

3. Duct, fittings, and dampers shall not be thrown or dropped.

B. Material Protection

1. Protect coated duct from damage due to normal handling during shipment and storage.

2. Protection shall be applied to the ends of the duct in order to prevent dirt and moisture from entering ducts and fittings.

3. Protection must be of suitable strength and material to withstand tearing and puncture.

4. Multiple pieces may be bolted together at the factory to provide protection and limit the number of open ends requiring protection.

C. Consignee must inspect shipment upon delivery and note any and all damages and discrepancies on bill of lading and notify manufacturer within 24 hours.

1.6 WARRANTY

A. Provide the ductwork manufacturer’s standard warranty.

B. Furnish the warranty to the Engineer upon final acceptance of the completed systems by the Owner.

PART 2 -- PRODUCTS

2.1 HANGERS AND SUPPORTS

A. Anchorage and bracing for all suspended ductwork and other distribution systems needs to be provided per 2016 IBC Section 1613/ASCE 7-10 Chapter 13, 2020 NBC Section 4.1.

B. Ductwork shall be firmly anchored or connected to supporting members.

C. Provide necessary hangers, supports, concrete inserts, and anchors for material and equipment to be installed.

D. No perforated strap hangers nor wire supports will be accepted.

E. Construct the anchors and inserts of 304 stainless steel.

F. Locate hangers and supports not greater than 10 ft from each expansion loop or joint.

G. Provide hangers and supports for ductwork and equipment in accordance with SMACNA standards.

2.2 GALVANIZED AND ALUMINUM DUCTWORK (ALL DUCTWORK SHALL BE ALUMINUM UNLESS OTHERWISE NOTED)

A. General

1. Provide air-tight and well-braced ductwork.

2. Carefully support the ductwork in horizontal runs, with rod and angle supports at no greater than 8 ft intervals.

3. Run ductwork as close as possible to the indicated layouts.

B. Construction

1. Construct sheet metal ducts and plenums with air-tight joints and seams in accordance with ASHRAE standards and the SMACNA Duct Construction Manual.

2. Tape the joints on concealed ducts with pressure-less tape and adhesive, except for welded and soldered joints.

3. Ductwork materials shall be aluminum, unless otherwise indicated.

4. Provide the following duct gauges, as a minimum:

Maximum Dimension of Duct inches	Galvanized Steel U.S. Standard Gauge	Aluminum B and S Gauge
12 and less	26	24
13 through 30	24	22
31 through 54	20	20
55 through 84	20	18

5. All low-pressure ductworks shall be designed for 3-in vacuum and pressure and be constructed of sheet metal of not less than the gauge designated in table above, and gauge designations provided by Brown 23 and Sharpe Standards.

6. The radius of bends shall be not less than 1.5 duct diameters, unless otherwise indicated.

7. Provide turning vanes on all mitered elbows and extractors, as required and indicated.

8. Except where accepted by the Engineer, provide fan discharge connections and ductwork reductions with duct side slopes not exceeding 30 degrees.

9. Properly insulate aluminum duct and supports from concrete or dissimilar metals by an applied bituminous coating or by rubber gaskets at contact points.

10. Construct interior partitions from aluminum, in accordance with the latest ASHRAE guide recommendations for construction for high-pressure rectangular duct work.

11. Construct the units in accordance with the ASHRAE guide recommendations for high-pressure ductwork.

12. Seams shall be lock-formed and mastic-filled.

13. Provide rectangular casing seams in the corners of the silencer shell in order to provide maximum unit strength and rigidity.

14. Provide interior partitions with die-formed entrance and exit shapes in order to provide the maximum aerodynamic efficiency and minimum self-noise characteristics in the sound attenuator.

15. Blunt noses or squared off partitions will not be accepted.

16. Use solid galvanized steel to attach the interior partitions to the casing, welded to the outer casing.

17. Attachment of the interior partitions to the tracks shall be such that a minimum of 4 thicknesses of metal exist at this location.

18. The track assembly shall stiffen the exterior casing, provide a reinforced attachment detail for the interior partitions, and shall maintain a uniform airspace width along the length of the silencer for consistent aerodynamic and acoustic performance.

19. In addition to the above attachments, secure the interior partitions to the outer casing with welded nose clips at both ends of the sound attenuator.

20. Achieve airtight construction by the use of a duct-sealing compound applied at the Site.

21. Sound traps shall not fail structurally when subjected to a differential air pressure of 8-in w.g. inside-to-outside of casing.

C. Seams

1. Provide double-locked seams.

2. Provide rectangular ducts with longer than a 12-in dimension with full-perimeter standing seams not less than 1-in high.

3. Provide reinforcements at intervals not greater than 30-in along the duct.

4. No "S" seams will be accepted.

D. Low-Pressure Ductwork

1. Design all low-pressure ductwork for 3-in vacuum and pressure.

2. Gauge designations refer to Brown and Sharpe Standards.

E. Access Doors

1. Provide access doors in the ductwork at all fire dampers, motorized and back draft dampers, filters, and as indicated.

2. Provide doors with the following features:

a. continuously hinged.

b. double-skinned.

c. constructed of either 22-gauge galvanized steel or 20-gauge aluminum to match the ductwork material.

d. one cam lock for sizes up to 16-in square or 2 cam locks for sizes over 16-in square.

e. match insulation thickness in door with ductwork insulation; and,

f. foam sealing gaskets on all four sides.

3. Access Doors Manufacturer, or Equal

    a. Ruskin, SMACNA Standard Duct Access Doors

F. Flexible Connections

1. Attach the equipment to the ducts through using flexible connections in order to facilitate removal of the units and for sound isolation.

2. Provide flexible connectors consisting of heavy duct canvas or woven glass fabric, silicon coated.

3. Canvas connectors shall be composed of a heavy cotton that is impregnated for waterproofing and fire retardance.

4. Use glass fabric where temperatures exceed 200 deg F.

5. The weight of the canvas shall be 20 ounces per sq yd.

6. The weight of the glass fabric shall be approximately 12 ounces per sq yd.

7. Flexible duct shall be insulated.

8. The maximum length of flexible duct shall not exceed 10 ft.

9. Flexible duct connections shall be composed of banded or flanged 8 oz canvas, reinforced plastic, or equal, at each point where a blower unit is connected to a duct.

10. Maintain a minimum clearance of 3-in between the duct and the source of vibration.

11. Provide materials that join and support the flexible duct in accordance with the latest edition of SMACNA.

G. Supports

1. Provide aluminum angles with 304 stainless steel threaded hanger rods as supports for horizontal ducts and plenums.

2. Supports for vertical ducts shall be aluminum of the angle bracket type.

3. Sufficiently brace inlet ducts to withstand the maximum negative pressure.

H. Seismic Restraints

1. Design the duct supports and restraints for static, dynamic, and seismic loads in Zone 4 in accordance with the International Building Code.

2. Seismic restraints shall not induce stresses in the ductwork caused by thermal expansion and contraction.

3. Comply with Section 01 33 17 – Structural Design, Support, and Anchorage

I. Duct Dimensions

1. Increase sheet metal duct dimensions by 2-in for internally lined ducts.

J. Corrosion-Resistant Ducts

1. Provide exhaust hoods as indicated, constructed of Type 316 stainless steel.

2. Fabricate the stainless-steel ducts of the same gauge as the galvanized steel ducts.

K. Balancing Dampers

1. Provide butterfly or multi-blade dampers as indicated and required in order to balance the air quantities to their indicated values.

2. Provide a locking quadrant on each manual damper, with easy access for operation.

L. Inspection Doors

1. Provide duct inspection doors consisting of a 12-in by 16-in steel frame with gasketing around its periphery, and either a hinged glass or a removable visual panel.

2. Doors shall be constructed of **Plexiglas**, **Lucite**, or equal.

3. On smaller ducts, provide separate 6-in by 8-in doors with 6-in by 6-in visual panels.

4. Provide duct inspection doors at each duct-mounted fire damper and electric duct heater.

M. Bird Screens

1. Provide removable bird screens on outside air intakes and exhaust air discharges to outside air.

2. Secure the screens in frames constructed of the same metal as the screens.

3. The bird screens shall be ½-in mesh by 14-gauge and shall be of same material and finish as duct, hood, louver, or equipment to which the screens are attached.

N. Turning Vanes

1. Square-turn elbows shall be fitted with shop-fabricated double-blade turning vanes mounted inside the rails.

2. Construction shall be of the same material as the ductwork and shall be rigid enough to prevent vibration at high air flow.

PART 3 -- EXECUTION

3.1 GENERAL

A. Floor, Wall and Roof Openings for New Construction

1. Provide necessary openings in walls, floors and roofs for the passage of heating and ventilating equipment in buildings.

2. The openings shall be as indicated, or as required to provide passage for the heating and ventilating Work.

3. Provide hanger and support inserts into masonry or structural steel as required for proper completion of the Work.

B. Floor, Wall and Roof Openings for Existing Construction

1. Provide openings for piping and equipment as required in the existing construction, whether or not they are specifically indicated.

2. Cut the openings in a neat and orderly manner without damaging existing structures. Do not overcut corners.

3. Patch openings to match the existing construction.

4. Provide and assume responsibility for hangers and supporting members in the existing masonry or structural steel as required for proper completion of the Work.

C. Interior and Exterior Wall Penetrations

1. Where ducts pass through exterior walls, interior partitions or pass through walls dividing two separate controlled areas, conceal the space between construction openings and the duct with sheet metal flanges of the same gauge as the duct.

2. Overlap the opening on 4 sides by at least 1 ½-in.

3.2 INSTALLATION

A. General

1. Field Measurements

a. Duct lengths shall be determined from measurements taken at the Site.

b. The indicated dimensions are approximate and shall not be used for fabrication.

2. Install ducts as indicated.

3. Necessary provisions shall be taken into consideration during fabrication and installation of ductwork to provide for expansion and contraction.

4. Ductwork shall be free from vibration when in operation.

5. Provide necessary vibration isolation devices.

6. Apply anti seize compound to bolt threads.

7. Provide smooth bends or internal turning vanes at elbows, tees, and other points where the air flow changes direction.

8. The inside of duct, specials, and fittings shall be smooth, clean, and free from blisters, sand and dirt.

9. Ductwork shall be airtight.

10. Joints shall be carefully and neatly constructed, as indicated and as recommended by the manufacturer.

11. Flanges

    a. Tighten flange bolts sufficiently to slightly compress the gasket and make a seal, but not so tightly as to distort the flanges.

    b. Provide a flat washer under each nut and bolt head.

12. Dampers

    a. Position the dampers to fit into the connecting ductwork at the indicated locations.

    b. Install axles in the horizontal position unless otherwise necessary for proper operation of the damper.

13. Supports and Hangers

    a. Support the ductwork in accordance with the manufacturer’s recommendations and as indicated.

    b. Duct supports shall comply with SMACNA Standards and applicable code requirements.

    c. Supports and hangers shall transmit loads into the building structural frame through a system of intermediate beams and struts as necessary to comply with the indicated requirements.

    d. Supports or hangers employing clip angles or similar devices for attachment to the duct will not be accepted.

    e. Design the supports to resist IBC seismic forces.

14. Alignment and Elevation

    a. Provide ductwork to the indicated lines and elevations, and slope as indicated to facilitate water drainage.

    b. Use laser beam equipment or surveying instruments to maintain alignment and elevation.

    c. If laser beam equipment is used, perform periodic elevation measurements with surveying instruments in order to verify accuracy.

B. Control Dampers

1. General

    a. Coordinate damper submittals for type, quantity, and size in order to ensure compatibility with sheet metal design.

    b. Follow the manufacturer's instructions for field installation of control dampers.

    c. Unless specifically designed for vertical blade application, mount the dampers with the blade axis horizontal.

2. Duct Openings

    a. Duct openings shall be free of obstructions and irregularities that might interfere with blade or linkage rotation or actuator mounting.

    b. Duct openings shall measure ¾-in larger than damper dimensions, and shall be square, straight, and level.

3. Damper Sections

    a. Individual damper sections, as well as entire multiple section assemblies, shall be completely square and free of racking, twisting, and bending.

    b. Measuring the damper sections diagonally from upper corners to opposite lower corners of each damper section, both dimensions shall be within 1/8-in of each other.

4. Shafts

    a. Install an extended shaft or jackshaft in accordance with the manufacturer's instructions.

    b. If a sticker on the damper face shows recommended extended shaft location, attach the shaft on the labeled side of damper to that blade.

5. Operation

    a. Damper blades, axels, and linkage shall operate without binding.

b. After installation but before system operation, cycle the damper in order to ensure proper operation.

c. On multiple section assemblies, sections shall open and close simultaneously.

6. Provide a visible and accessible indication of damper position on the drive shaft end.

7. Support ductwork or damper actuator in areas of damper when required in order to prevent sagging due to damper or damper actuator weight.

8. After installing low-leakage dampers with seals, caulk between the frame and the duct or opening in order to prevent leakage around the perimeter of damper.

C. Smoke Dampers

1. Coordinate smoke damper and smoke/fire damper installations, wiring, and checkout in order to ensure that the dampers function properly and that they need to be wired in to the plant SCADA system.

2. Immediately report discrepancies to the Engineer not less than 14 Days prior to inspection by the code authority having jurisdiction.

3.3 DUCT CLEANING

A. The ducts shall be blown clean of dust and debris using compressed air.

B. Do not use system fans for duct cleaning.

3.4 FIELD TESTING

A. Leak-test the ductwork after installation, in accordance with the National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems, a publication of the Associated Air Balance Council (AABC).

B. The maximum allowable leakage criteria shall be in conformance with ASHRAE standards.

END OF SECTION

SECTION 23 34 00 – HVAC FANS

PART 1 -- GENERAL

1.01 SUMMARY

A. Provide fans, blowers, ventilators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. Where 2 or more fans, blowers, ventilators or appurtenances of the same type or size are required, they shall be furnished by the same manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit certified fan curves for each fan.

C. O&M Data

1. Submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts:

1. Drive Belts: Provide one for each fan.

1.05 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
03 30 00	Cast-in-Place Concrete
09 96 00.10	High Performance Coatings

C. Reference Standards

Air Moving and Conditioning Association (AMCA)	
AMCA 300-14	Reverberant Room Method for Sound Testing of Fans
Standard 99	Standards Handbook, Reverberant Room Method for Sound Testing of Fans.
Standard 210	Laboratory Methods of Testing Fans for Rating
American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)	
	HVAC Applications chapter in “Seismic Restraint Design”
	Spec 01 33 17 – Seismic and Wind Design Criteria
Institute of Electrical and Electronics Engineers, Inc. (IEEE)	
112	Standard Test Procedure for Polyphase Induction Motors and Generators
National Electrical Manufacturers Association (NEMA)	
MG 112.53a	Motors and Generators
National Fire Protection Association (NFPA)	
70	National Electric Code (NEC)
90A	Standard for the Installation of Air Conditioning and Ventilating Systems
Occupational Safety and Health Act (OSHA)	
Underwriters Laboratories Inc. (UL)	
	Product Directories

1.06 MOTORS

A. All motors shall conform to the latest IEEE and NEMA requirements for mechanical and electrical characteristics, including service factors.

B. Motors shall be in accordance with the requirements of Division 26.

C. Each motor shall bear the manufacturer’s nameplate with complete motor data.

D. Each motor shall be of ample size and construction to carry continuously all loads which might be imposed by the piece of equipment it drives throughout the full range of operation of the equipment, and the maximum motor loading shall in all cases be less than or equal to the nameplate horsepower rating, exclusive of the service factor.

E. All 2-speed motors shall be 2-winding motors.

PART 2 -- PRODUCTS

2.01 TUBULAR BACKWARD-INCLINED INLINE EXHAUST FANS (EF-01)

A. Provide tubular backward-inclined inline exhaust fans as indicated.

B. Fans shall be of the tubular centrifugal type, with backward inclined wheels.

C. The fan housing shall be constructed of continuously welded heavy-gauge steel in order to minimize air leakage.

D. Housing and bearing supports shall be constructed of structural steel members in order to prevent vibration and to rigidly support the shaft and bearings.

E. Fan Wheel

1. The wheel shall be of the non-overloading backward-inclined centrifugal type, and of aluminum construction.

2. The wheel shall be statically and dynamically balanced.

3. The wheel cone and fan inlet cone shall be carefully matched and shall be provided with precise running tolerances for maximum performance and operating efficiency.

F. Shafts shall be constructed of turned, precision ground, and polished steel, and shall be sized such that the first critical speed is at least 25 percent over the maximum operating speed for each level of construction.

G. Bearings

1. Bearings shall be of the heavy-duty, grease-lubricated, and self-aligning type.

2. Bearings shall be selected for a minimum L-10 life of 80,000 hours at maximum operating speed for each level of construction.

H. Inline tubular centrifugal fans shall bear the AMCA Certified Ratings Seals for both sound and air performance.

I. Fans shall be completely coated outside and on surfaces in contact with the air stream with High performance Epoxy, or equal except where otherwise indicated.

J. Manufacturer, or Equal

1. Greenheck, Model AX

2. Cook

2.02 CEILING TOILET EXHAUST FANS, DIRECT-DRIVE (EF-02)

A. Provide ceiling toilet exhaust fans as indicated.

B. Fans shall be of the forward-curved, direct-drive type.

C. The fan housing and scroll shall be constructed of corrosion-resistant galvanized steel.

D. Grilles shall be constructed of white high-impact polystyrene (non-yellowing) with 2 attachment screws, and shall provide an 85-percent free area.

E. Provide the fan with a round-curved outlet connection.

F. Fan Wheels

1. Fan wheels shall be of the forward-curved type and shall be constructed of calcium carbonate-filled polypropylene.

2. Wheels shall be dynamically balanced for vibration-free operation.

G. The integral backdraft damper shall be chatterproof.

H. The entire fan, motor, and wheel assemblies shall be removable without disturbing the housing.

I. Fan Motors

1. Provide motors with thermal overload protection sized to match fan loads.

2. Nominal fan motor speeds shall not exceed 1550 RPM.

3. Fan motors shall be suitably grounded and mounted on vibration isolators.

4. Fan motor housing shall be complete with mounting angles.

J. Fans shall be completely coated outside and on surfaces in contact with the air stream with High performance Epoxy, or equal except where otherwise indicated.

K. Manufacturer, or Equal

1. Greenheck, Model SP

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Fans, blowers, ventilators, and hoods shall be installed in strict accordance with the manufacturer's recommendations.

B. Pipe the housing drains to the nearest utility drain

END OF SECTION

SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 -- GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

1.02 SUMMARY

A. Section includes:

1. Rectangular and Square ceiling diffusers

2. Perforated diffusers

3. Adjustable bar registers

4. Fixed face registers and grilles

B. Related Sections:

1. Section 08 91 00- Louvers for fixed and adjustable louvers and wall vents , whether or not they are connected to ducts.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Abbreviations and Acronyms

C. Reference Specifications

08 91 00	Louvers
09 96 00.10	High-Performance Coatings

D. Reference Standards

American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

1.04 ACTION SUBMITTALS

A. Product Data

1. Data sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number size and accessories furnished.

B. Samples for initial Selection: For Diffusers, registers, and grilles with factory applied color finishes.

C. Samples for verification: For diffusers, registers, and grilles in manufacturers standard sizes to verify color selected.

1.05 INFORMATIONAL SUBMITTALS

A. Coordinated Drawings: Reflected Ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using the input from installers of the items of involved:

1. Ceiling suspension assembly members.

2. Method of attaching hangers to building structures.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers access panels, and special moldings.

5. Duct access panels.

B. Source quality control reports.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Provide supply and return registers and grilles, and all supply diffusers as indicated.

B. The sizes, capacities, and deflection of each unit shall be as indicated on the Drawings.

C. Submittal

1. Data sheet: Indicate materials of construction, finish, and mounting details, performance data including throw and drop, static pressure drop and noise ratings.

D. The following schedule shall be followed:

Air Terminal Type	**Border Type**	**Manufacturer, Model and Material**	**Optional damper**	**Neck Type**
Supply Grilles (SG)	Surface Mount	**Titus Model 300FL Aluminum**; **Tuttle and Bailey**; or equal: with ½-	yes	Rectangular

Air Terminal Type	Border Type	Manufacturer, Model and Material	Optional damper	Neck Type
		in x ½in x ½-in aluminum grid		
Return Registers (RR)	Surface mount	**Titus Model 350FL**; **Tuttle and Bailey**; or equal	yes	Rectangular

E. Registers, grilles and diffusers shall be constructed of aluminum.

F. The finish shall be a white baked-on enamel.

G. Accessory equipment shall be constructed of aluminum, or steel if aluminum is not available, and provided with a whit baked-on enamel.

H. The proper border style shall be selected by the Contractor to suit the installation conditions.

I. Registers, grilles, and diffusers located in corrosive atmospheres, as indicated, shall be painted with a special protective coating in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

2.02 ACTION SUBMITTALS

A. Product Data

1. Data sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, noise ratings.

2.03 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate Diffusers, registers, and grilles according to ASHRAE 70, " Method of Testing for Rating the Performance of Air outlets and Inlets."

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling Mounted Outlets and Inlets : Drawings indicate general arrangement of ducts, fittings and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, air flow pattern, throw and pressure drop. Make final locations where indicated , as much as practical. For units installed in lay in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors and fire dampers.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers and grilles to air patterns indicated, as directed, before starting air balancing.

END OF SECTION

SECTION 23 70 00– CENTRAL HVAC EQUIPMENT

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Provide the air handling units and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. Single Manufacturer: Where 2 or more air handling units or appurtenances of the same type or size are to be provided, they shall be furnished by the same manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
23 05 00	Common Work Results for HVAC

C. Reference Standards

Air-Conditioning, Heating and Refrigeration Institute (AHRI)	
AHRI 410	Forced-Circulation Air Cooling and Air Heating Coils
AHRI 430	Standard for Application of Central-Station Air Handling Units
AHRI 260	Sound Rating of Ducted Air Moving and Conditioning Equipment
Air Movement and Control Association International, Inc. (AMCA)	
AMCA 99	Standard Handbook
AMCA 210	Laboratory Methods of Testing Fans for Rating Purposes
AMCA 300	Test Code for Sound Rating Air Moving Devices
AMCA 301	Method of Publishing Sound Ratings for Air Moving Devices
AMCA 500	Test Methods for Louvers, Dampers, and Shutters
AMCA 611-95	Methods of Testing Airflow Measurement Stations for Rating
American Bearing Manufacturers Association (ABMA)	
ABMA STD 9	Load Ratings and Fatigue Life for Ball Bearings
American National Standards Institute (ANSI)	
ANSI Z223.1	Natural Fuel Gas Code Handbook
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASHRAE 52.1/52.2	Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size

ASHRAE 62	Ventilation for Acceptable Indoor Air Quality
ASHRAE 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
Canadian Electric Code (CEC)	
Canadian Gas Association (CGA)	
CGA B149.1	Natural Gas Installation Code
American Society of Mechanical Engineers (ASME)	
ASTM International (ASTM)	
ASTM A653	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM A924	Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
ETL Testing Laboratories (ETL)	
International Organization for Standardization (ISO)	
ISO-9002	Quality Standard
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 54	National Fuel Gas Code
NFPA 90A	Installation of Air Conditioning and Ventilation Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
SMACNA	Low Pressure Duct Construction Standards
Underwriters Laboratories (UL)	
UL 181	UL Standard for Safety Factory-Made Air Ducts and Air Connectors
ANSI/UL 900	Test Performance of Air Filter Units

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Furnish a certified fan curve for each fan.

1.04 CODE REQUIREMENTS

A. Perform the Work in strict accordance with the State Mechanical Code, the State of Washington, City of Carson and other authorities having jurisdiction.

B. Obtain the required certifications and become thoroughly familiar with the local codes.

C. Obtain and pay for all necessary permits.

PART 2 -- PRODUCTS

2.01 MAKE UP AIR HANDLING UNIT WITH ELECTRIC HEAT (MAU-01)

A. General

1. Air Handling Units shall be as indicated on the Air Handling Unit Schedule.

2. Unless otherwise indicated, air handling units are to be shipped to the Site in one piece, factory-assembled.

3. Modular units assembled to achieve a close approximation to the intent of this Section will not be considered.

4. Where indicated and applicable, equipment shall be pre-wired and factory-certified by an approved testing agency such as ETL, UL, or CSA prior to shipment.

5. Pre-wired air handling units shall bear an approved label with identification marks, electrical data, and necessary cautions as required by the National Electric Code

6. Electrical circuits shall undergo a dielectric strength test, and shall be factory-tested and checked as to proper function.

7. The air handling units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of 15 continuous years of proven production experience.

B. Construction

1. The casing shall be constructed of minimum 14-gauge satin coat galvanized sheet metal.

2. Clean the surfaces with a degreasing solvent to remove oil and metal oxides, and prime with a 2-part acid-based etching primer.

3. The finish coat shall be an electrostatically-applied enamel, applied to all exposed surfaces.

4. Unprotected metal and welds shall be factory-coated.

5. Provide continuous high-pressure sealant between each panel.

6. Walls, roofs and floors shall be of formed construction, with at least 2 breaks at each joint.

7. Joints shall be secured by sheet metal screws or pop rivets.

8. Wall and floor joints shall be "broken in," and outdoor units roof joints shall be "broken out" (exposed) for rigidity.

9. Joints shall be caulked with a water-resistant sealant.

10. The following components shall be provided with a 22-gauge solid or 24-gauge perforated (40 percent free area) galvanized metal liner over insulated areas:

    a. fan sections

    b. coil sections

    c. filter sections

    d. access sections

    e. humidifier sections

    f. underside if unit (where visible)

11. Casing Floors in Walk-in Sections

    a. Fabricate casing floors in walk-in sections from 14-gauge galvanized checker plate steel.

    b. Provide reinforcing channels under the floor in order to minimize deflection.

12. Cooling Coil Drain Pans

    a. Fabricate cooling coil drain pans from stainless steel to form an integral part of the floor paneling, a minimum of 2-in deep, with welded corners.

    b. Extend the drain pans a minimum of 6-in downstream of the coil face, and provide the pans with a 1 ½-in stainless steel M.P.T. drain connection.

    c. Provide the drain pans with a fast pan and slope and pitch such that there is no standing water.

    d. Provide intermediate fast pans between cooling coils where required for effective moisture removal.

C. Wash-down Liner

1. Screw and caulk the wash-down liner in order to allow for power washing without the risk of wetting the internal insulation.

2. Break the solid liner over a 2-in drain pan upturn in order to allow the water to shear into the pan.

D. Access Doors

1. Provide access doors to the following components:

    a. fans and motors;

b. filters;

c. dampers and operators;

d. access plenums and humidifiers/wet cells;

e. electrical control panels; and,

f. burner compressor compartments.

2. Access doors shall be large enough for easy access.

3. The removal of screwed wall panels will not be accepted.

4. Provide hinged access doors with an extruded neoprene gasket, full lining, and a minimum of 2 Camlock-style fasteners for units up to 48-in high.

E. Marine Lights

1. Provide marine lights with Lexan, or equal, bulb covers, and glass globes with a metal protective cage in each section that is provided with an access door.

2. Wire the lights in an EMT conduit to a switch with a pilot light.

F. Insulation

1. The air handling units shall be internally insulated with 2-in thick 1 ½ lb./cu.ft. neoprene-coated fiberglass thermal insulation.

2. Cover longitudinal insulation joints and butt ends by a sheet metal break in order to prevent the erosion of exposed edges.

3. Drain pans and floor areas shall be insulated on the underside.

G. Drain Pan

1. The floor shall act as the drain pan (wash-down, interior) and shall be provided complete with 2-in upturn standing seams around its perimeter and welded corners in order to ensure the floor is watertight.

2. Provide 1 ½-in drain connections to completely drain the base pan.

H. Provide a galvanized drain under the complete fan section where the fan is located downstream of a humidifier.

I. Provide indoor suspended units with ½-in diameter holes in the base channels in order to accommodate hanger rods.

J. Service Platform

1. Provide a service platform, factory-fabricated, a minimum of 42-in wide.

2. Run the platform the entire unit length, located on the service access side.

3. Provide 3-lb metal grating, suitably reinforced and complete with angle iron side rails and 5-in kick plates.

4. Provide an access ladder to the platform.

K. Service Corridor

1. Insulate the service corridor (integral) with 1 -in thick, nominal 3 lb/cu ft. density, acoustic insulation.

2. Fully line the corridor with a 22-gauge solid liner.

3. Construct the floor from 14-gauge galvanized checker plate steel with welded seams.

L. Access Doors

1. Provide access doors to the service corridor complete with zinc-plated piano hinges and brass pins in welded steel frames.

2. Provide lockable **Leverlok**-style handles.

3. Provide access doors from the service corridor to internal unit components as indicated.

M. Electrical Appurtenances

1. Provide the corridor with marine lights with **Lexan**-style globes with a metal protective cage wired in EMT to a switch with a pilot light.

2. Provide the corridor with a 2 KW electric baseboard heater with integral wall-mounted thermostat, and a duplex service receptacle.

3. The electrical appurtenances shall be rated at 120v, 60 Hz, single-phase.

N. Reclaim Units

1. In air-to-air heat reclaim units, provide exhaust section drain pans as an integral part of the floor paneling,

2. Provide the drain pans a minimum of 2-in deep, with welded corners.

3. Extend the drain pans over the full exhaust fan plenum, and connect with a 1-in M.P.T. drain connection.

O. Weatherproofing

1. Air handling units shall be weatherproofed and equipped for installation outdoors.

2. Provide 1-in galvanized inlet screens on louvers, air intake hoods, and exhaust openings.

3. Provide rain gutters or diverters over access doors.

4. Caulk joints with a water-resistant sealant.

5. Turn up roof joints 2-in, and provide a 3-break interlocking design.

6. Extend outer wall panels a minimum of ¼-in below the floor panel.

7. Provide drain trap connections for the field supply and installation of drain traps.

P. Roof Mounting Curb

Q. Air Handler Cabinets

1. Construct air handling unit cabinets utilizing a framework of steel channels supporting composite insulated metal panels, 2 -in thick.

2. Construction

a. Fabricate panels from roll-formed steel, chemically fused to a foamed-in-place rigid polyurethane expanded foam core.

b. Unit shall be painted with earthy or dark earth tone. Paint sample shall be sent to Engineer, Architect and Owner for review and approval before fabrication.

c. Panels shall be single-piece.

d. Provide steel facing sheets at the longitudinal edges of the panel with roll-formed male and female interlocking geometry, fully supported by the foamed-in-place insulation core.

e. Apply fasteners in the panels from the exterior panel face, concealed in the panel edge joint for positive connection to the structural support.

3. Facing and Liner Sheets

a. Fabricate facing and liner sheets from galvanized steel with a stucco embossed pattern.

b. Tension-level the steel and conform to ASTM A653 grade 33 (A) structural quality, and provide a hot-dipped galvanized coating to ASTM A924 and G-90 designation.

c. Provide facing sheets with a low-profile shadow like rib repeating, running the longitudinal direction of the panel.

4. Core

a. Provide core material of a foamed-in-place, multi-component polyurethane or isocyanurate polymeric insulation.

b. Provide the insulation core with a tongue-and-groove profile shape in order to allow positive insulation-to-insulation contact in the panels.

c. Laminated styrene panels will not be accepted.

5. Provide self-drilling or tapping fasteners to attach the panels to the structural frame shall be self drilling or tapping with neoprene washers and hex head. Sealants used in the internal panel joint shall be butyl based.

6. Finish for exterior and interior shall be factory applied silicone modified polyester of 0.2 mil primer and 0.8 mil top coat USDA, H of A approved for food contact areas.

a. The cabinet panels shall comply with the following performance tests and properties:

b. Design load/deflection criteria and fastening pattern with of limitation of 1/200th under positive and negative pressures, based on a test design loading of 20 PSF;

c. Withstand at least 2 million alternate cycles of 1/180 deflection without evidence of delamination, core cracking, or permanent deformation;

d. Air leakage not exceeding 0.0015 CFM/sq ft of wall area, at a pressure differential of 20 psi;

e. No uncontrolled water penetration through panel joints when tested at 20 psi;

f. Nominal thermal resistance of R = 7.8-in thickness; and,

g. the following standards of compliance for fire test, and labeled as such:

7. (FM) Factory Mutual Corp

8. (WH) Warnock-Hersey

9. (UL) Underwriters Laboratory, Inc.

10. (ULC) Underwriters Laboratory Canada

R. FANS

1. Provide centrifugal fans rated in accordance with AMCA (Air Movement and Control Association) Standard Test Code, Bulletin 210.

2. The fan manufacturer shall be a member of AMCA.

3. Dynamically balance the fans and fan assemblies during the factory test run.

4. Fan Shafts

    a. Select fan shafts for stable operation at least 20 percent below the first critical RPM.

    b. Provide fan shafts with a rust-inhibiting coating.

5. Equip single, low-pressure, forward-curved fans of 18-in or less diameter with permanently lubricated cartridge ball bearings, supported by a 3-point "spider" bearing bracket in the fan inlets.

6. Equip other forward-curved fan assemblies with greaseable pillow block bearings, supported on a rigid structural steel frame.

7. Equip airfoil and BI fans with greaseable, self-aligning ball or roller-type pillow block bearings.

8. Provide airfoil and BI fans of a plenum-type configuration where indicated.

9. Provide thrust restraint isolators parallel to the shaft centerline when required to minimize axial movement and bending movements of the blower assembly.

10. Provide drive-side bearings on plenum fans of the adapter-style in order to ensure even clamping of the bearing sleeve to the shaft.

11. Provide standard belt guards on all units with walk in sections over 60-in high.

12. Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 9-in to 15-in diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 1-in 25mm static deflection designed to achieve high isolation efficiency. Provide seismic restraint type isolators containing compressed spring. Use of separate bumper or snubber is not acceptable. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

13. All single-phase belt drive motor applications shall include rubber isolation for motors ¼ HP through 1 ½ HP. Provide internal spring isolation for single phase motors over 1 ½ HP.

14. Provide single extended grease line from far side to access side bearing.

15. Provide fan scroll access doors and drains.

16. Fan motors shall be TEFC (totally enclosed fan cooled).

17. Screens

    a. Provide an inlet screen.

b. Removable screens at access doors will not be accepted.

18. Drives

a. General

1) Provide adjustable drives on fans with motors of 7 ½ HP or less.

2) Provide fixed drives on fans with larger motors.

3) Provide the drives with a rust-inhibiting coating.

4) Provide for drive changes, as required during the air balance procedure.

5) Provide a brushless electrical coupling to the rotating coil; brushes will not be accepted.

6) Locate pulley and sheaves on the motor shaft-entry side of the drive nearest the motor face.

7) Locate drive bearings directly under the pulley grooves for uniform loading of bearings.

8) The internal surface of the drive drum shall be copper-lined for maximum efficiency.

9) Unit shall be capable of operating continuously at any output speed without causing any increase in motor heating.

10) The drive shall not cause or produce any harmonics or voltage distortion and consequently does not require filtering devices such as chokes.

11) Drive shall be factory supplied and installed.

19. Controls

a. Speed Controller

1) Provide a 115-volt, 3-amp speed controller to accept current, voltage, or pressure transducer signal input and interface to energy management system as required.

2) The controller shall be UL-approved and housed in a NEMA 1 enclosure, pre-wired with a HAND-OFF-AUTO selector, manual operator speed potentiometer on front cover, and optional speed meter.

3) The controller shall provide independent adjustable soft-start for pre-set ramp up of the drive.

4) In event of power failure or momentary interrupt, the unit shall automatically restart with preset ramp-up when power is restored.

5) Controls shall be UL-listed.

S. ELECTRIC HEAT

1. Electric resistance heaters shall be provided in the capacities, voltage, and steps of control as noted in the Schedules, and shall bear a listing or certification mark from an authorized agency.

2. Heater elements shall be installed a minimum of 12-indownstream from air filters.

3. Insulation in heating sections shall be fiber-reinforced and foil-faced.

4. Should discharge air exceed 105 deg F, use motors in air stream with Class F insulation.

5. If the discharge air temperature is greater than 150 deg F, mount motors out of the heated air stream.

6. Wiring

   a. Terminate heater element wiring in a full-height enclosure at one end of the heater.

   b. Terminate internal wiring on clearly identified terminal blocks.

   c. Furnish a wiring diagram on the enclosure cover.

7. Cut-outs

   a. Equip heaters with an automatic reset disc type thermal cut-out.

   b. Heaters rated at 30 kW and less shall be equipped with an additional manual reset disc type thermal cut-out.

8. Heater elements shall be open type nickel-chromium construction, (2/3 Ni, 1/3 Cr) with a maximum rating of 22.5 kw/sq ft ; sheathed coils shall be provided with a maximum rating of 13 kw/sq ft.

9. Mechanically secure coil terminal pins and insulate from the frame by means of non-rotating ceramic bushings.

10. Electric heater elements mounted in a corrosive air stream, as indicated in the schedules, shall be of the open type of high nickel content: 80percent Ni, 20 percent Cr

11. Heating coil casings shall be corrosion resistant and constructed of galvanized steel of suitable gauge as required by the approval agency.

12. Provide heaters with aluminum protective screens on inlet and outlet sides.

13. SCR

a. Provide the discharge air control with a silicon-controlled rectifier (SCR) performing time-based sine wave phase control.

b. The SCR shall be controlled by a factory-installed solid-state proportional integral controller.

T. Electric Make-up Air Handling Units Manufacturer, or Equal

a. Engineered Air Model LMK

b. Greenheck

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All air handling equipment shall be installed by a qualified Contractor in strict accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 23 70 10– AIR CONDITIONING EQUIPMENT

PART 1 -- GENERAL

1.01 THE SUMMARY

A. Provide air conditioning units and appurtenances, complete and operable, in accordance with the Contract Documents.

B. Where two or more air conditioning units or appurtenances of the same type or size are required, they shall be furnished by the same Manufacturer.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures

C. Reference Standards

Air-Conditioning, Heating and Refrigeration Institute (AHRI)	
AHRI 410	Forced-Circulation Air Cooling and Air Heating Coils
AHRI 430	Standard for Application of Central-Station Air Handling Units
AHRI 260	Sound Rating of Ducted Air Moving and Conditioning Equipment
Air Movement and Control Association International, Inc. (AMCA)	
AMCA 99	Standard Handbook
AMCA 210	Laboratory Methods of Testing Fans for Rating Purposes
AMCA 300	Test Code for Sound Rating Air Moving Devices
AMCA 301	Method of Publishing Sound Ratings for Air Moving Devices
AMCA 500	Test Methods for Louvers, Dampers, and Shutters
AMCA 611-95	Methods of Testing Airflow Measurement Stations for Rating
American Bearing Manufacturers Association (ABMA)	
ABMA STD 9	Load Ratings and Fatigue Life for Ball Bearings
American National Standards Institute (ANSI)	
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)	
ASHRAE 52.1/52.2	Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size
ASHRAE 62	Ventilation for Acceptable Indoor Air Quality

ASHRAE 90.1	Energy Standard for Buildings Except Low-Rise Residential Buildings
Building Automation Solutions (BAS)	
Canadian Standards Association (CSA)	
Department of Energy (DOE)	
National Fire Protection Association (NFPA)	
NFPA 90A	Installation of Air Conditioning and Ventilation Systems
Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)	
SMACNA	Low Pressure Duct Construction Standards
Underwriters Laboratories (UL)	
ANSI/UL 900	Test Performance of Air Filter Units

D. The Work shall be in strict accordance with the State Mechanical Code, the State of Washington, City of Carson and other authorities having jurisdiction.

E. Obtain the required certifications and become thoroughly familiar with the local codes.

F. Obtain and pay for all necessary permits.

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00– Submittal Procedures.

B. The submittals shall include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Shop drawings: indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics, and connection requirements.

PART 2 -- PRODUCTS

2.01 DUCTED SPLIT-TYPE AIR CONDITIONING UNIT (AC-01, CU-01)

A. General – System Description

1. The systems shall be (cool/heat) split system heat pump.

    a. The heat pump system shall consist of a single outdoor condensing unit, single indoor unit, and optional wired or wireless controller.

    b. The condensing unit shall be a horizontal discharge, 208, 1Ph, 60Hz. The evaporator shall be concealed duct type.

B. QUALITY ASSURANCE

1. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.

2. All wiring shall be in accordance with the National Electrical Code (N.E.C.).

3. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

4. A full refrigerant charge for the condensing unit only shall be provided. Additional refrigerant is required based on diameters and lengths of system liquid refrigerant lines and indoor equipment model and quantity.

5. Service and installation manuals must be readily available on the manufacturer's website at all times without entering a username and password.

C. WARRANTY

1. Commercial Installations: This warranty applies to heating and air conditioning units installed in buildings other than residences and covers defects in materials and workmanship that appear under normal use and maintenance. Warranty coverage begins on the "installation date". The installation date is one of two dates: (1) The installation date is the date that the unit is originally installed. (2) If the date the unit is originally installed cannot be verified, the installation date is three months after the manufacture date. The warranty lasts for a period up to 5 YEARS.

2.02 OUTDOOR UNIT - (CU-01)

A. GENERAL

1. The heat pump outdoor unit shall be capable of guaranteed operation in cooling mode between 23°F ~ 120°F (-5°C to 49°C) outside ambient temperatures.

2. The heat pump outdoor unit shall be capable of guaranteed operation in cooling mode below 23°F (-5°C) down to -4°F (-20°C) outside ambient temperature with the addition of factory provided front and rear wind baffles (accessory).

3. The heat pump outdoor unit shall be capable of guaranteed operation in heating mode between -13°F ~ 75°F (-25°C ~ 24°C) ambient temperatures.

4. The heat system shall provide high heating capacity at -4°F (-20°C).

5. The heat pump outdoor unit shall have a base pan heater as standard.

6. Condensing unit salt spray test method: ASTM B117-18 - the heat exchanger showed no unusual rust or corrosion development to 2,280 hours.

7. The heat pump outdoor unit shall have an accumulator.

8. The heat pump outdoor unit shall auto-restart after power loss.

9. The heat pump outdoor unit shall have a high pressure safety switch, fuse, over-current protection, over-voltage protection, temperature limit protection logic, and compressor overload sensing.

10. The heat pump outdoor unit shall have snow accumulation prevention option setting to prevent snow drifting against an idle outdoor unit.

11. The heat pump outdoor unit shall have the capability to be configured as heating/cooling, cooling only, or heating only via outdoor unit option setting.

12. The system shall support limiting the maximum operating current from 50% - 100% via outdoor unit, wired controller or central controls (Maximum Current Control).

B. Refrigerant Piping:

1. Both refrigerant lines from the outdoor unit to indoor unit shall be insulated.

2. Installed refrigerant pipe length and vertical separation shall be within the published manufacturer's specifications.

C. Unit Cabinet:

1. The chassis shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

D. Fan:

1. The heat pump outdoor unit shall be furnished with axial fan(s) with BLDC motor(s).

2. All fan motors shall have inherent protection, thermal protection, and have permanently lubricated bearings, and be completely variable speed.

3. All fan motors shall be mounted for quiet operation.

4. All fans shall be provided with a raised guard to prevent contact with moving parts.

5. The outdoor unit shall have horizontal discharge airflow.

E. Refrigerant:

1. The system shall use R-32 refrigerant.

2. Additional refrigerant may be required. Additional charge is based on installed refrigerant pipe diameters and lengths.

3. The unit shall include an R-32 alarm output plug for notification of R-32 leak detection when a supported indoor unit’s refrigerant leak detector detects a refrigerant leak (MIM-B14U accessory is required, only applies when the indoor unit has a R-32 leak detector).

F. Coil:

1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.

2. The coil shall be protected with an integral metal guard.

3. The Heat Pump condensing unit salt spray test method: ASTM B117 - the heat exchanger showed no unusual rust or corrosion development to 2,280 hours.

G. Compressor:

1. The compressor shall be an inverter driven, DC voltage, twin BLDC rotary compressor.

2. A crankcase heating device shall be factory mounted in/on the compressor.

3. The heat pump outdoor unit compressor shall have a soft-start function to reduce electricity demand during system start and to increase compressor reliability.

4. The compressor will be equipped with an internal thermal overload.

5. The compressor shall be mounted to avoid the transmission of vibration.

H. Electrical:

1. The outdoor unit electrical power shall be 208 volts, 1 phase, and 60 hertz.

2. The unit shall be capable of satisfactory operation within voltage limitations of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).

3. The outdoor unit shall be controlled by integral microprocessors.

4. The control circuit between the indoor units and the outdoor unit shall be 0.5VDC - 7VDC completed using stranded, annealed copper conductor, 16 AWG, two-core cable to provide total integration of the system.

5. The outdoor unit shall provide power to the indoor unit with 14 AWG X 3 power wire (2 X high voltage wires, 1 X ground). The power wire shall be run from the condensing unit to indoor unit.

2.03 CEILING-CONCEALED DUCTED, INDOOR UNIT (AC-01)

1. General Description

   a. The indoor unit shall be a ceiling-concealed ducted indoor fan coil design that mounts above the ceiling with a 2-position, field adjustable return and a fixed horizontal discharge supply and shall have a modulating expansion device.

2. Indoor Unit

a. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air (Nitrogen gas) before shipment from the factory.

b. The indoor unit shall have an optional R-32 leak detector (purchased separately, field installed). When the indoor unit detects an R-32 leak, the system shall enable mitigation control functions. The indoor unit shall include an R-32 alarm output plug for notification of R-32 leak detection (leak detector MRS-L32U and MIM-B14U accessories are required).

c. The indoor unit shall feature comfort humidity control in a 1:1 application. Utilizing an integral humidity sensor, the system optimizes the indoor unit coil temperature according to the dew point, maximizing energy savings while still providing space dehumidification and occupant comfort.

d. The indoor unit shall have an integral condensate pump as standard with 29" maximum lift from the bottom of the indoor unit.

e. The indoor unit shall have an integral condensate float switch to disable the unit in the event of condensate overflow.

3. Unit Cabinet:

a. The unit shall be space saving, ceiling-concealed, ducted.

b. The cabinet shall be constructed of insulated galvanized steel.

4. Fan:

a. The indoor unit fan assembly shall be two or three (dependent on capacity) Sirocco fans direct driven by a single motor.

b. The indoor fan shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.

c. Standard external static pressure is 0.1" WC. Acceptable range: 0" – 0.24" WC.

d. The indoor fan shall consist of three (3) speeds, Low, Mid, and High. Auto fan speed setting is available.

e. The indoor unit shall have a ducted air outlet and ducted return air system (field provided).

f. The fan speed shall be adjustable by optional remote controller or manufacturer provided service software according to external static pressure.

g. The indoor unit shall only serve areas in the same room (cannot serve areas in different fire envelopes).

5. Filter:

    a. Return air shall be filtered by means of a standard factory installed return air filter on rear of unit.

    b. Optional return connection through rear or bottom of unit with removal and replacement of return air conversion plate. Other filtration is field provided (recommended).

6. External Heat Control

    a. External heat control functionality allows for configuration of fan operation during auxiliary heat operation, defrost, and emergency heat (MIM-B14U accessory required).

    b. External heat control configuration settings include outside ambient external heat lockout, outside ambient compressor lockout, and time delay options (MIM-B14U accessory required).

    c. Emergency heat functionality allows the system to continue controlling the external heat source even when system errors prevent the heat pump from operating (MIM-B14U accessory required).

    d. External heat control functionality allows for configuration of fan operation during auxiliary heat operation, defrost, and emergency heat

    e. Emergency heat functionality allows the system to continue controlling the external heat source

7. Coil:

    a. The indoor coil shall be of nonferrous construction with slit fins on copper tubing.

    b. The tubing shall have inner grooves for high efficiency heat exchange.

    c. All tube joints shall be brazed with phos-copper or silver alloy.

    d. The coils shall be pressure tested at the factory.

    e. A condensate pan and drain shall be provided under the coil.

    f. The condensate shall be gravity drained from the fan coil.

    g. The coil fins are coated with hydrophilic paint.

    h. Both refrigerant lines to the ceiling-concealed ducted indoor units shall be insulated.

8. Electrical:

a. The unit electrical power shall be 208 volts, 1 phase, 60 hertz.

b. The control circuit between the indoor unit and the outdoor unit shall be 0.5VDC - 7VDC completed using stranded, annealed copper conductor, two-core, 16 AWG cable to provide total integration of the system

c. The indoor unit shall have a thermal fuse under high-voltage terminal block to disable unit in the event of overheating due to electrical malfunction/poor connection.

9. Controls:

a. The indoor unit shall have the capability to be controlled via local wired controllers, wireless controllers, multi-unit Wi-Fi adapters, and central control options provided by the HVAC manufacturer.

b. This unit shall use controls provided by the HVAC manufacturer to perform functions necessary to operate the system. Please refer to the “Controls” section of this guide specification for details on controllers and other control options.

c. The indoor unit shall have a removable EEPROM on its PCB to store all unit data. All data on the indoor unit EEPROM shall be viewable from the manufacturer provided service software. The indoor unit main EEPROM shall be removable allowing replacement of indoor unit PCB without losing digital, field programmed data. The indoor unit removable EEPROM shall store the following unit data: unit model number, unit serial number, unit PCB firmware and MICOM version, and field programmed unit name/tag viewable on controls and service software.

d. The indoor unit shall feature a Dual Set point function that allows users to set separate heating and cooling set temperatures using supported local wired controller and central control options. Dual set temperature allows the user to specify a deadband where the unit will not heat or cool when room temperature is between the heating and cooling set temperatures. Dual set temperature can be used with heat pump or heat recovery systems.

e. The indoor unit shall feature an Emergency Temperature Output (ETO) function that will provide a signal when an indoor unit is in error status. When enabling ETO, a high room temperature threshold can also be programmed to provide a signal when the room temperature limit has been exceeded. The ETO signal can be used to activate backup systems, provide a simple signal to a building management system, or to provide a simple visual/audible notification locally (ex: LED, buzzer, etc.). A MIM-B14U External Contact Control interface module is required for each unit that will provide or receive an ETO signal.

2.04 AIR CONDITIONER MANUFACTURERS, OR EQUAL

A. Samsung Model AC009

B. York

C. Trane

D. Carrier

E. McQuay

PART 3 -- EXECUTION

3.01 INSTALLATION

A. All air conditioning equipment shall be installed in strict accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 26 00 00 – ELECTRICAL WORK, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical WORK, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to all Sections in Division 26, except as otherwise indicated.

C. The WORK of this Section is required for operation of electrically-driven equipment provided under Specifications in other Divisions.

D. The Contractor's attention is directed to the requirement for proper coordination of the WORK of this Section with the WORK of equipment Specifications, the WORK of instrumentation Sections,.

E. Concrete, excavation, backfill, and steel reinforcement required for encasement, installation, or construction of the WORK of the various Sections of Division 26 is included as a part of the WORK under the respective Sections, including duct banks, manholes, handholes, equipment housekeeping pads, and light pole bases.

F. Equipment supports and foundations shall be in conformance with the requirements of Section 46 10 00 – Equipment General Provisions.

1.2 REFERENCE STANDARDS

NEC (NFPA 70)	National Electrical Code: 2023 Edition
NETA	International Electrical Testing Association
NEMA 250	Enclosure for Electrical Equipment (1000 Volts Maximum)

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Electrical equipment shall be listed by and shall bear the label of Underwriters' Laboratories, Inc. (UL) or an independent testing laboratory acceptable to the local code enforcement agency having jurisdiction.

C. Installation of electrical equipment and materials shall comply with OSHA Safety and Health Standards (29 CFR 1910 and 29 CFR 1926, as applicable), state building standards, and applicable local codes and regulations.

D. Where the requirements of the specifications conflict with UL, NEMA, NFPA, or other applicable standards, the more stringent requirements shall govern.

1.3 SIGNAGE AND MARKINGS

A. Identification

1. Provide danger, caution, and warning signs and equipment identification markings in accordance with applicable federal, state, OSHA, and NEC requirements.

B. Local Disconnect Switches

1. Legibly mark each local disconnect switch for motors and equipment in order to indicate its purpose, unless the purpose is indicated by the location and arrangement.

C. Warning Signs

1. 600 Volts Nominal, or Less

a. Mark entrances to rooms and other guarded locations that contain live parts with conspicuous signs prohibiting unqualified persons from entering.

2. Greater than 600 Volts

a. Buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at greater than 600 volts nominal shall be lockable.

b. Provide permanent and conspicuous warning signs reading as follows: DANGER – HIGH VOLTAGE – KEEP OUT.

3. Mark indoor electrical installations that are open to unqualified persons and contain metal-enclosed switchgear, unit substations, transformers, and other similar associated equipment over 600 volts nominal, with appropriate caution signs.

4. Outside Branch Circuits and Feeders over 600 Volts

a. Post warning signs in plain view where unauthorized persons might come in contact with live parts: WARNING – HIGH VOLTAGE – KEEP OUT.

D. Isolating Switches

1. Provide isolating switches not interlocked with an approved circuit-interrupting device with a sign warning against opening them under load.

1.4 PUBLIC UTILITIES REQUIREMENTS

A. Contact the serving utility and verify compliance with requirements before construction.

1. Electrical – as shown on drawings:
Public Utility District No. 1 of Skamania County
1492 Wind River Hwy
Carson, WA 98610
Phone: (509) 427-5126

2. Digital Subscriber Line (DSL) Telephone – 60/10Mbps down/upload minimum:
CenturyLink
Phone: (833) 320-2794

B. Coordinate schedules and payments for WORK by utilities.

C. Where conduits and conductors in the WORK are indicated to be larger, heavier schedule, or have greater protective coating than utility requirements, provide the larger size, heavier schedule, or greater protection.

D. Provide electrical service as indicated and as required by the serving utility.

E. Verify and provide service conduits, fittings, transformer pad, grounding devices, and service wires not provided by the serving utility.

F. Verify with the utility the exact location of each service point and type of service, and pay charges levied by the serving utilities as part of the WORK.

1.5 PERMITS AND INSPECTION

A. Obtain permits and pay inspection fees according to the General Conditions.

B. Pay connection and turn-on service charges required by the utility company.

1.6 CONTRACTOR SUBMITTALS

A. General

1. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

2. Custom-prepare Shop Drawings.

3. Drawings or data indicating "optional" or "as required" equipment will not be accepted.

4. Cross out options not proposed or delete from the Shop Drawings.

B. Shop Drawings. Include the following:

1. Complete material lists stating manufacturer and brand name of each item or class of material.
2. Shop Drawings for grounding WORK not specifically indicated.
3. Front, side, rear elevations, and top views with dimensional data.
4. Location of conduit entrances and access plates.
5. Component data.
6. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size, and cable numbers.
7. Method of anchoring, seismic requirements, weight.
8. Types of materials and finish.
9. Nameplates.
10. Temperature limitations, as applicable.
11. Voltage requirement, phase, and current, as applicable.
12. Front and rear access requirements.

13. Test reports.

14. Grounding requirements.

C. Catalog Cuts

1. Submit catalog cuts or photocopies of applicable pages of bulletins or brochures for mass-produced, non-custom manufactured material.

2. Stamp the catalog data sheets in order to indicate the Project name, applicable Specifications Section and Paragraph, model number, and options.

D. Materials and Equipment Schedules

1. Within 30 Days of the commencement date in the Notice to Proceed, deliver to the Engineer a complete list of materials, equipment, apparatus, and fixtures that are proposed for use.

2. Include in the list the type, size, name of manufacturers, catalog number, and such other information as required to identify the item.

E. Technical Manuals

1. Submit complete information in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

2. As-Built Drawings

a. Prepare as-built drawings, showing invert and top elevations and routing of duct banks and concealed below-grade electrical installations.

b. Furnish the drawings to the Engineer in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

1.7 AREA DESIGNATIONS

A. General

1. Designations for raceway system enclosures shall comply with the requirements of Section 26 05 33 – Electrical Raceway Systems.

2. Designations for electrical WORK specifically indicated in other Sections shall comply with the requirements of those Sections unless indicated otherwise.

3. Designations for other electrical WORK not included in the above Paragraphs shall be as follows:

AREA	NEMA ENCLOSURE CLASSIFICATION						
	1	3R	4	4X	12		Notes
Chem Bldg. Control Room					X		See 1.7.A.5.
Chem Bldg. chemical rooms				X			

Outdoors		X					

4. Designations for electrical WORK not included in the above paragraphs shall be NEMA 4X.

5. Electrical equipment requiring ventilation may have openings with externally replaceable and reusable filters and be rated NEMA 1G.

B. Material Requirements

1. Provide sealing fittings in chlorine acid areas.

2. Construct NEMA 3R enclosures of Type 304 or 316 stainless steel, or aluminum.

3. Construct NEMA 4X enclosures of Type 304 or 316 stainless steel, except in chlorine and HFS areas where non-metallic enclosures shall be provided.

4. Do not coat NEMA 4X enclosures.

5. Construct NEMA 1 and 12 enclosures of steel, and prime and coat with ANSI 61 light grey paint.

1.8 TESTS

A. The Contractor shall be responsible for factory and field tests indicated in Division 26, as required by the Engineer, and as required by other authorities having jurisdiction.

B. Furnish necessary testing equipment.

C. Pay the costs of the tests, including replacement parts and labor, due to damage resulting from damaged equipment or from testing and correction of a faulty installation.

D. Reporting

1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.

2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.

3. Submit field test reports for review prior to Substantial Completion.

E. Remove and replace equipment or material that fails a test, or, if the Engineer approves, repair and retested for compliance.

F. Corrections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

1.9 DEMOLITION AND RELATED WORK

A. General

1. Perform electrical demolition WORK as indicated.

2. The CONTRACTOR is cautioned that demolition WORK may also be indicated on non-electrical Drawings.

3. Coordinate with all trades regarding electrical de-energization, disconnection, and removal, and the overall sequence of construction.

B. Electrical Requirements for Removed Equipment

1. Remove dedicated wiring and exposed conduits back to the source.

2. Abandon in place wiring that shares conduits with other equipment wiring, except power wiring.

3. Remove power wiring from the power source to the first pullbox, junction box or manhole remote from the panel, and abandon in place the remaining wiring.

4. Encased Conduits

a. Abandon in place wiring routed through encased conduits.

b. Cut encased conduits flush to the floor and grout flush with the floor. Remove exposed conduit to the first fitting/coupling before encasement. Remove the fitting/coupling and replace with a 5-thread conduit cap.

5. Remove remote-mounted starters, disconnect switches, circuit breakers, sensors, and transmitters.

C. Where new lighting and receptacles are installed, remove old lighting, receptacles, switches, wiring, and conduits.

D. Junction Boxes

1. Wiring and conduits indicated to be extended shall be terminated in a new junction box with terminal strips.

2. Provide a junction box with a NEMA rating in accordance with the area in which it is located and sized as required.

3. Properly identify wires and terminals before disconnection.

E. Removed materials and equipment not indicated to be returned to the OWNER shall, upon removal, become the CONTRACTOR's property and shall be disposed of off- Site.

F. Remove and relocate material and equipment indicated to be relocated or reused and reinstall with care in order to prevent damage.

G. Place materials indicated to be returned to the OWNER in boxes, with the contents clearly marked, and store at a location determined by the ENGINEER.

1.10 CONSTRUCTION SEQUENCING

A. General

1. Because the continuance of plant operation during demolition and expansion process is critical, the Contractor shall carefully examine the WORK to be provided in, on, or adjacent to existing equipment.

2. Schedule the WORK, subject to Owner's approval, to minimize required shutdown time.

3. Submit a written sequencing request, including the sequence and duration of activities to be performed during plant shutdown.

4. Switching, safety tagging, and the like, as required for plant shutdown or to isolate existing equipment, shall be performed by the Contractor.

5. In no case shall the Contractor begin any WORK in, on, or adjacent to existing equipment without written authorization from the Engineer.

B. Modifications

1. Perform modifications or alterations to existing electrical facilities as required to successfully install and integrate the proposed electrical equipment as indicated.

2. Perform modifications to existing equipment, panels, and cabinets in a professional manner.

3. Repair coatings to match existing.

4. The costs for modifications to existing electrical facilities that are required for a complete and operating system shall be included as part of the WORK.

C. Existing Utilities

1. Exercise extreme caution when digging trenches to not damage existing underground utilities.

2. The cost of repairs of damages caused during construction shall be included as a part of the WORK.

D. Field Verifications

1. Visit the Site before submitting a Bid to become better acquainted with the WORK of this Contract.

2. The lack of knowledge will not be accepted as justification for extra compensation to perform the WORK.

3. The Contractor shall be responsible for identifying available existing circuit breakers in lighting panels for the intended use as required.

4. The Contractor shall be responsible for field verifying the available space in substation switchboards to integrate new power circuit breakers.

5. The cost for the above verifications shall be included as part of the WORK.

E. Installation of Temporary Equipment

1. To facilitate the continuous operation of existing equipment, provide the temporary equipment as indicated.

2. Submit installation and connection details for review and acceptance by the Engineer.

3. Costs associated with these temporary installations shall be included as part of the WORK.

4. Temporary wiring and equipment shall remain the property of the Contractor unless indicated otherwise.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide equipment and materials that are new and are the products of experienced and reputable manufacturers in the industry.

B. Provide equipment and materials listed by UL and bearing the UL label, where UL requirements apply.

C. Provide similar items in the WORK as products of the same manufacturer.

D. Provide equipment and materials of industrial grade standard of construction.

E. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.

F. On devices indicated to display dates, display the year as 4 digits.

G. Temperature Ratings of Equipment Terminations

1. Provide terminations and lugs rated for use with 75-degree C conductors.

2. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

2.2 MOUNTING HARDWARE

A. Miscellaneous Hardware

1. Provide nuts, bolts, and washers constructed of stainless steel.

2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.

3. Struts

    a. Construct struts for mounting of conduits and equipment of 316 stainless steel.

    b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.

    c. Strut Manufacturer, or Equal: **Unistrut**; **B-Line**

4. End Caps

    a. Provide plastic protective end caps for all exposed strut ends below 8’ AFF.

    b. End Caps Manufacturer, or Equal: **Unistrut, Model P2860**

5. Anchors

    a. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors, and ceilings.

    b. Wood plugs will not be accepted.

    c. Anchor Manufacturer, or Equal: **"Power-Bolt"** or **"Power-Stud"** as manufactured by **Power Fasteners, Inc.**; similar by **Star**.

2.3 ELECTRICAL IDENTIFICATION

A. Nameplates

1. Fabricate nameplates from white-letter, black-face laminated plastic engraving stock, such as **Formica Type ES-1** or equal.

2. Securely fasten each nameplate, using fasteners constructed of brass, cadmium-plated steel, or stainless steel, and screwed into inserts or tapped holes as required.

3. Provide engraved characters of the block style, with no characters smaller than 1/8 inch top to bottom.

B. Conductor and Equipment Identification

1. Provide imprinted plastic-coated cloth marking devices, such as manufactured by Brady, Thomas & Betts, or equal.

2. Alternatively, provide heat-shrunk plastic tubing, imprinted split-sleeve markers cemented in place.

2.4 PROTECTIVE MATTING

A. Provide full-width, high-voltage switchboard matting in front of indoor switchgear, service equipment, panelboards and motor control centers.

B. For 600-volt equipment, provide matting that is 1/4 inch thick and at least 36 inches wide rated at least 17kV.

C. Matting Manufacturer, or Equal

1. **Honeywell, Salisbury; Rhino Mats**

2.5 SOLID-STATE POWER MONITORING DEVICE

A. Provide solid-state metering where indicated. Enclosures minimum requirements shall be in accordance with Paragraph 1.7 above.

B. Include CT's and PT's of ratios as indicated or as recommended by the equipment manufacturer.

1. Current Transformer (if used): Current transformers shall be rated to withstand the operational, short circuit, and voltage impulse conditions, and shall conform to ANSI C57.13. The ratings shall be as recommended by the equipment manufacturer. The current transformer shall be either of the wound, window, or bar type and shall have 5 ampere secondary burden and accuracy class shall be suitable for the connected load. Current transformers shall be solidly anchored within the equipment enclosure.

2. Potential Transformer (if used): Potential transformers shall be dry type. The ratings and accuracy shall be as recommended by the equipment manufacturer and suitable for the connected load. The voltage class shall be not less than installed gear. Potential transformers shall be protected with current limiting fuses on the primary and secondary sides.

C. The solid-state power monitoring devices shall measure, display and communicate the following parameters:

1. Current (A), each phase, average, and neutral

2. Voltage (V), each phase, and average

3. Power

a. Real (W), each phase, and average

b. Reactive (VAR), each phase, and average

c. Apparent (VA), each phase, and average

4. Energy

a. Real (kWh), each phase, and average

b. Reactive (kVARh), each phase, and average

c. Apparent (kVAh), each phase, and average

5. Frequency

6. Time and date

7. Demand

a. System current (A)

b. System real power (kW)

c. System reactive power (kVAR)

d. System Apparent power (kVA)

8. Power factor (PF)

9. %Total harmonic distortion (THD) Current

10. %Total harmonic distortion (THD) Voltage

11. The meter shall measure power quality (sag/swell, harmonics, and transients)

D. The meter shall have a serial data communications port.

E. Solid state metering shall be **G.E. "PQM", Eaton (Cutler-Hammer) "Power Xpert Meter 350 (PXM-350) series", Square D "Power-Logic"**, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Incidentals

1. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.

2. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

B. Field Control of Location and Arrangement

1. The Drawings diagrammatically indicate the desired location and arrangement of outlets, conduit runs, equipment, and other items.

2. Exact locations shall be determined by the Contractor in the field, based on the physical size and arrangement of equipment, finished elevations, and other obstructions.

3. Follow the locations on the Drawings, however, as closely as possible.

4. Conduits

a. Where conduit development drawings or "home runs" are indicated, route the conduits in accordance with those requirements.

b. Provide exposed or encased routings as indicated, except conceal conduit in finished areas unless indicated otherwise.

c. Size conduits encased in a slab for conduit OD not to exceed 1/3 of the slab thickness and lay out and space as to not impede concrete flow.

5. Placement

a. Install conduit and equipment in such a manner as to avoid obstructions, to preserve headroom, and to keep openings and passageways clear.

b. Locate luminaires, switches, convenience outlets, and similar items within finished rooms as indicated.

c. Where exact locations are not indicated, such locations will be determined by the Engineer.

d. If equipment is installed without instruction and must be moved, the cost of moving shall be included as part of the WORK.

e. Slightly adjust luminaire locations in order to avoid obstructions and to minimize shadows.

6. Circuits

a. Wherever conduits and wiring for lighting and receptacles are not indicated, it shall be the Contractor's responsibility to provide lighting and receptacle-related conduits and wiring as required, based on the actual installed fixture layout and the circuit designations as indicated.

b. Provide No. 12 AWG minimum wiring, and 3/4-inch minimum conduits (exposed) and one-inch minimum conduits (encased).

c. Where circuits are combined in the same raceway, derate conductor ampacities in accordance with NEC requirements.

7. Workmanship

a. Install materials and equipment in strict accordance with the printed recommendations of the manufacturer and using workers skilled in the WORK.

b. Coordinate installation in the field with other trades in order to avoid interferences.

8. Protection of Equipment and Materials

a. Fully protect materials and equipment against damage from any cause.

b. Cover materials and equipment, both in storage and during construction, in such a manner that no finished surfaces will be damaged, marred, or splattered with water, foam, plaster, or paint.

c. Keep moving parts clean and dry.

d. Replace or refinish damaged materials or equipment, including faceplates of panels and switchboard sections, as part of the WORK.

C. Provide incoming utility power equipment in conformance with the utility's requirements.

D. Starters in HVAC equipment which are indicated in Section 23 05 00 – Common Works Results for HVAC.

E. Provide control wiring operating at 120 volts and less as indicated in Section 23 05 00 – Common Works Results for HVAC.

3.2 CORE DRILLING

A. Perform core drilling as required for the installation of raceways through concrete walls and floors.

B. Base the locations of floor penetrations, as may be required, on field conditions.

C. Verify exact core drilling locations based on equipment actually furnished as well as exact field placement.

D. To the extent possible, identify the existence and locations of encased raceways and other piping in existing walls and floors with the Owner prior to any core drilling activities.

E. Repair damage to encased conduits, wiring, and piping as part of the WORK.

3.3 CONCRETE HOUSEKEEPING PADS

A. Provide concrete housekeeping pads for indoor floor-standing electrical equipment in areas with non-level floors, or wet areas. Dry areas with level floors do not require pads.

B. Extend housekeeping pads for equipment, including future units, 3-1/2 inches above the surrounding finished floor or grade, and at least 2 inches larger in both dimensions than the equipment, unless otherwise indicated.

C. Provide concrete housekeeping curbs for conduit stub-ups in indoor locations that are not concealed by equipment enclosures.

3.4 EQUIPMENT ANCHORING

A. Floor-supported, wall, or ceiling-hung equipment and raceways shall be anchored in place by methods that will meet seismic requirements in the area where the Project is located. Refer to Section 01 33 17 – Structural Design, Support and Anchorage for support and anchorage requirements.

B. Provide wall-mounted panels that weigh more than 500 pounds or that are within 18 inches of the floor with fabricated steel support pedestals.

C. If the supported equipment is a panel or cabinet enclosed within removable side plates, match supported equipment in physical appearance and dimensions.

D. Provide transformers hung from 4-inch stud walls and weighing more than 300 pounds with auxiliary floor supports.

E. Provide leveling channels anchored to the concrete pad for MCC’s, switchgear and other electrical equipment.

F. For outdoor floor-mounted gear provide non-corroding shims at each anchor point to level the gear and protect it from corrosion. Seal gaps to minimize insect and rodent

G. Manufacturer's Recommendations

1. Anchoring methods and leveling criteria in the printed recommendations of the equipment manufacturers are a part of the WORK of this Contract.

2. Submit such recommendations as Shop Drawings as indicated.

3.5 EQUIPMENT IDENTIFICATION

A. Provide nameplates for panelboards, control and instrumentation panels, starters, switches, and pushbutton stations.

B. In addition to nameplates, equip control devices with standard collar-type legend plates.

C. Identify control devices within enclosures as indicated and similar to the subparagraph above.

D. Provide suitable inscribed finish plates for toggle switches that control loads out of sight of switches and for multi-switch locations of more than 2 switches.

E. Use equipment names and tag numbers, where indicated, on nameplates. Include Owner-generated QR labels for individual assets, where applicable.

F. Provide typewritten circuit directories for panelboards, that accurately reflect the outlets connected to each circuit.

G. Terminal Blocks

1. Label termination points on terminal blocks by identifiers on the blocks.

2. Provide identifiers that have been preprinted by the terminal manufacturer or custom-printed.

3. Hand-lettered markers will not be accepted.

H. Provide arc-flash labels for all distribution equipment, stand-alone disconnects, starters, and VFDs. Fill in all values as required by NFPA 70E, and as calculated as part of the Protective Device Study. Verify that all settings as prescribed by the approved Protective Device Study have been implemented in the field.

3.6 CLEANING

A. Before final acceptance, thoroughly clean the electrical WORK of cement, plaster, and other materials.

B. Remove temporary tags, markings, stickers, and the like.

C. Remove oil and grease spots with a non-flammable cleaning solvent by carefully wiping and scraping cracks and corners.

D. Apply touch-up paint to scratches on panels and cabinets.

E. Vacuum clean electrical cabinets and enclosures. Do not use compressed air to clean cabinets.

F. Clean luminaires inside and out. Replace failed lamps.

G. Properly dispose cleaning debris and refuse off-site.

END OF SECTION

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SECTION 26 01 26 – ELECTRICAL TESTS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. This Section specifies the WORK necessary to test, commission, and demonstrate that the electrical work satisfies the criteria of these Specifications and functions as required by the Contract Documents.

B. The WORK of this Section includes furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein and functional testing of power and controls not tested under Division 40 - Instrumentation, shall be completed before commencement of the 7 Day test of Section 01 75 00 - Equipment Testing and Plant Startup. This scope may require the Contractor to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.

C. The requirements of Section 26 00 00 - Electrical Work, General, apply to the WORK of this Section.

D. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.

1.2 REFERENCES

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. General

1. The publications listed below form a part of this specification to the extent referenced.

2. Where a date is given for reference standards, the edition of that date shall be used. Where no date is given for reference standards, the latest edition available on the date of the Notice Inviting Bids shall be used.

C. American National Standards Institute (ANSI)

D. Institute of Electrical and Electronics Engineers, Inc. (IEEE)

E. IEEE 400-2001, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems

F. IEEE 576-2000, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications

G. InterNational Electrical Testing Association (NETA)

H. NFPA 70, National Electrical Code (NEC)

1.3 SUBMITTALS

A. Submit in accordance with Section 01 33 00 – Submittal Procedures, Contractor Submittals.

B. Submit complete system test procedures for review. Test procedures shall include but not be limited to:

1. Detailed procedures in sufficient detail to verify conformance with these Specifications.

2. Incorporation of the Test Record Sheets included at the end of this Section.

3. Detailed comprehensive testing schedule including:

a. Each major piece of electrical distribution equipment.

b. Each major electrical subsystem.

c. Duration of each test.

d. Milestone test completion date.

e. Ambient Conditions at time of test

f. Date of test results submittals following completion of the tests.

g. Names and qualifications of the individual(s) responsible for performing the testing.

C. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the “as-left” settings of all devices, relays, circuit breakers, etc.

D. Test result shall be submitted in one submittal

E. Test reports shall be based on NETA’s latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA’s Acceptance Testing Specifications latest edition.

1.4 COMMISSIONING

A. Commissioning during the 7 Day test in Section 01 75 00 – Equipment Testing and Plant Startup shall not be attempted until all subsystems have been found to operate satisfactorily. Commissioning shall only be attempted as a function of normal plant operation in which plant process flows and levels are routine and equipment operates automatically in response to flow and level parameters or computer command, as applicable. Simulation of process parameters shall be considered only upon receipt of a written request by the Contractor.

B. Motor Current Tabulation

1. The motor current tabulation required by Section 26 05 73 – Protective Device Studies shall reflect the values occurring during commissioning.

2. Switchboard ammeters and kilowattmeters shall be recorded every half-hour during the commissioning.

3. Motors which have current/power measurement capabilities shall have this data recorded every 5 minutes while operating during commissioning.

4. Power monitored amperes, voltage, and kilowatts for each phase shall be recorded every 5 minutes during commissioning.

PART 2 -- TESTING & REPORTS

2.1 PRE-ENERGIZATION AND OPERATING TESTS

A. The complete electrical system shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the protective device study and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

1. Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.

2. Protective Relays. Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

3. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.

4. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

5. Metering Circuits. All metering circuits shall be verified to operate correctly from voltage and current sources, similarly to protective relay circuits.

6. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

7. Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

B. Test Report. A test report covering the results of the tests required in the Pre-Energization and Operating Tests shall be delivered to the authority having jurisdiction prior to energization. Acceptance Testing shall be in accordance with NETA ATS-2017, *For Electrical Power Equipment and Systems*, published by the InterNational Electrical Testing Association.

2.2 TEST REQUIREMENTS

A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.

1. Lighting: Switching, include remote control, if present in system. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.

2. Power Instrumentation: Demonstrate that voltmeter and ammeter switches are functional. Demonstrate that kilowatt meters are within catalog accuracy as installed.

   a. Visual and Mechanical Inspection

      1) Compare equipment nameplate data with drawings and specifications.

      2) Inspect physical and mechanical condition.

      3) Verify tightness of electrical connections.

      4) Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case-shorting contacts, as applicable.

      5) Verify freedom of movement, end play, and alignment of rotating disk(s).

   b. Electrical Tests

      1) Verify accuracy of meters at all cardinal points.

      2) Calibrate watthour meters according to manufacturer’s published data.

      3) Verify all instrument multipliers.

      4) Verify that current transformer and voltage transformer secondary circuits are intact.

3. Demonstrate mechanical and/or electrical interlocking by attempting to subvert the intended sequence.

4. Activate ground fault tripping by operating test features provided with ground current protective systems and by injecting a known and reasonable current in the ground current sensor circuit. In general, ground fault tripping should occur at a ground current equivalent to 20 percent of phase current. Current injection is not required of circuit 400 amperes or less.

5. Low Voltage Cables-600 volts Maximum

   a. Visual and Mechanical Inspection

      1) Compare cable data with drawings and specifications.

2) Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.

3) Inspect bolted electrical connections for high resistance using one of the following methods:

a) Use of low-resistance ohmmeter

b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS- 2017, Table 100.12.

c) Perform thermographic survey in accordance with below Section Thermographic Survey.

4) Inspect compression-applied connectors for correct cable match and indentation.

5) Inspect for correct identification and arrangements.

6) Inspect cable jacket insulation and condition.

b. Electrical Tests

1) Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be one minute.

a) Motor feeders tested with motors disconnected and controller open.

b) Motor control circuits tested and verified for proper operation with control stations and overcurrent devices connected.

c) Panelboard feeders tested with feeder breaker open and panel-board connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.

d) Conductors of main lighting feeders, including lighting panel with branch circuits open.

e) Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid state device.

f) Equipment which may be damaged during this test shall be disconnected.

g) The Engineer shall be consulted if minimum insulation values cannot be obtained.

2) Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

3) Perform continuity test to insure correct cable connection.

c. Test Values – Visual and Mechanical

1) Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Bolt-torque levels should be in accordance with NETA ATS-2017, Table 100.12 unless otherwise specified by the manufacturer.

3) Results of the thermographic survey shall be in accordance with the below Section Thermographic Survey.

d. Test Values – Electrical

1) Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS-2017 Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.

3) Cable shall exhibit continuity.

4) Deviations in resistance between parallel conductors shall be investigated.

6. Cables, Medium and High-Voltage

a. Visual and Mechanical Inspection

1) Compare cable data with drawings and specifications.

2) Inspect exposed sections of cables for physical damage.

3) Inspect bolted electrical connections for high resistance using one of the following methods:

a) Use of low-resistance ohmmeter.

b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS- 2017, Table 100.12.

c) Perform thermographic survey in accordance with below section Thermographic Survey.

4) Inspect compression-applied connectors for correct cable match and indentation.

5) Inspect shield grounding, cable support, and termination.

6) Verify that visible cable bends meet or exceed ICEA and manufacturer's minimum allowable bending radius.

7) Inspect fireproofing in common cable areas.

8) If cables are terminated through window-type current transformers, make an inspection to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.

9) Visually inspect jacket and insulation condition.

10) Inspect for correct identification and arrangements.

b. Electrical Tests

1) Perform a shield-continuity test on each power cable by ohmmeter method.

2) Perform an insulation-resistance test utilizing a megohmmeter with a voltage output of at least 2500 volts. Individually test each conductor with all other conductors and shields grounded. Test duration shall be one minute.

3) Perform resistance measurements through all bolted connections with low-resistance ohmmeter.

4) Perform a dc high-potential test on all cables. Adhere to all precautions and limits as specified in the applicable NEMA/ICEA Standard for the specific cable. Perform tests in accordance with ANSI/IEEE Standards 400-2001 and 576-2000. Install cables in final position after terminations including stress cone makeup. Cables shall not be connected to equipment. Test procedure shall be as follows, and the results for each cable test shall be recorded as specified herein. Test voltages shall not exceed 80 percent of cable manufacturer's factory test value or the maximum test voltage in NETA ATS- 2017, Table 100.6.

a) Insure that the input voltage to the test set is regulated.

b) Current-sensing circuits in test equipment shall measure only the leakage current associated with the cable under test and shall not include internal leakage of the test equipment.

c) Record wet- and dry-bulb temperatures or relative humidity and temperature.

d) Test each section of cable individually. Cables shall not be connected to equipment.

e) Individually test each conductor with all other conductors grounded. Ground all shields.

f) Terminations shall be adequately corona-suppressed by guard ring, field reduction sphere, or other suitable methods as necessary.

g) Insure that the maximum test voltage does not exceed the limits for terminators specified in ANSI/IEEE Standard 48, IEEE 386, or manufacturer's specifications.

h) Apply a dc high-potential test in at least five equal increments until maximum test voltage is reached. No increment shall exceed the voltage rating of the cable. Record dc leakage current at each step after a constant stabilization time consistent with system charging current.

i) Raise the conductor to the specified maximum test voltage and hold for 15 minutes on shielded cable and five minutes on non-shielded cable. Record readings of leakage current at 30 seconds and one minute and at one minute intervals thereafter.

j) Reduce the conductor test potential to zero and measure residual voltage at discrete intervals.

k) Apply grounds for a time period adequate to drain all insulation stored charge.

l) When new cables are spliced into existing cables, the dc high-potential test shall be performed on the new cable prior to splicing in accordance with above. After test results are approved for new cable and the splice is completed, an insulation-resistance test and a shield-continuity test shall be performed on the length of new and existing cable including the splice. After a satisfactory insulation-resistance test, a dc high-potential test shall be performed on the cable utilizing a test voltage acceptable to owner and not exceeding 60 percent of factory test value.

m) Cable testing and report submittal shall be performed by an organization sanctioned by the manufacturer of the cable to be tested. Testing shall verify the quality of cable terminations. Test results for medium and high voltage cable shall be submitted to the Engineer 30 Days prior to the time schedule for equipment energization.

n) High potential tests shall not be repeated without authorization by the Engineer.

c. Test Values

1) Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

2) Bolt-torque levels should be in accordance with NETA ATS-2017, Table 100.12 unless otherwise specified by manufacturer.

3) Microhm or millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's data is not available, investigate any values which deviate from similar connections by more than 50 percent of the lowest value.

4) Shielding shall exhibit continuity. Investigate resistance values in excess of ten ohms per 1000 feet of cable.

5) Graphic plots shall be made of leakage current versus step voltage at each increment and leakage current versus time at final test voltages.

a) The step voltage slope should be reasonably linear.

b) Capacitive and absorption current should decrease continually until steady state leakage is approached.

6) In order to be acceptable, the cable must withstand the test high voltage without breakdown, have steady or decreasing leakage current during the high potential test, and have satisfactory comparable megger readings in each megger test. Test results shall be submitted to the Engineer, stating equipment used and time of test.

7. Test ground interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.

8. A functional test and check of electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:

a. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.

b. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels, as required by Section 26 05 73 – Protective Device Studies.

c. Setting of protective relays in conformance with results of the Short Circuit Study required by Section 26 05 73 - Protective Device Studies and testing of relays to assure that relays will trip at the current value and time required by the Study.

d. Circuit Breakers

1) Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer.

2) Time and pickup setting shall correspond to the recommendations of the Short Circuit Study.

3) Setting shall be tabulated and proven for each circuit breaker in its installed position.

4) Test results shall be certified by the person performing the tests and shall be submitted to the Engineer.

9. Complete ground testing of grounding electrodes per requirements below prior to operating the equipment.

B. Subsystem testing shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the Engineer and after process control devices have been adjusted as accurately as possible. Alarm conditions shall be simulated for each alarm point, and alarm indicators shall be checked for proper operation. It is intended that the Contractor will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.

C. Metering and indication lights for motors and other devices shall be tested for proper operation.

D. All control circuits such as motor, interlock and remote shall be tested for proper operation.

E. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.

F. Motor operated valves shall be tested after having been phased and tested for correct motor rotation and after travel and torque limit switches have been adjusted by a representative of the valve manufacturer. Tests shall verify status indication, proper valve travel, and correct command control from local and remote devices.

G. All lighting panels, circuits and fixtures; and power panels, circuits and receptacles shall be tested for proper operation.

H. Provide ground resistance tests on the main grounding electrode or system in the presence of the Engineer and submit results

1. Visual and Mechanical Inspection

a. Verify ground system is in compliance with drawings and specifications.

2. Electrical Tests

a. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81 on the main grounding electrode or system.

b. The earth resistance of each ground electrode shall be measured and recorded before electrodes are connected to the grounding loop.

c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and/or derived neutral points.

3. Test Values

a. The resistance between the main grounding electrode and ground shall be no greater than five ohms for commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner.

b. Investigate point-to-point resistance values which exceed 0.5 ohm.

I. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.

J. THERMOGRAPHIC SURVEY

1. Visual and Mechanical Inspection

a. Inspect physical, electrical, and mechanical condition.

b. Remove all necessary covers prior to thermographic inspection. Utilize appropriate caution, safety devices, and personal protective equipment.

2. Equipment to be inspected shall include all 120 volt and higher current-carrying devices including all switchgear, switchboards, distribution panels, cable and bus connections, motor control centers and starters, disconnect switches, and other critical equipment. Testing of lighting luminaires, field instrumentation, SCADA & PLC’s are not required.

3. Provide report including the following:

a. Description of equipment to be tested.

b. Discrepancies.

c. Temperature difference between the area of concern and the reference area.

d. Probable cause of temperature difference.

e. Areas inspected. Identify inaccessible and/or unobservable areas and/or equipment.

f. Identify load conditions at time of inspection.

g. Provide photographs and/or thermograms of the deficient area.

h. Recommended action.

4. Test Parameters

a. Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1°C at 30°C.

b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.

c. Thermographic surveys should be performed during periods of maximum possible loading but not less than 40 percent of rated load of the electrical equipment being inspected. Refer to ANSI/NFPA 70B-2010, Section 11-17 (Infrared Inspection).

5. Test Values

a. Suggested actions based on temperature rise can be found in Table 100.18.

6. RE-INSPECTION

a. All items that are reported deficient in the thermography reports section of the inspection report shall be re-inspected after repairs have been made.

b. Original specification will apply to re-inspections.

c. Submit re-inspection reports and indicate that repairs have fixed the anomaly or indicate any remaining anomalies.

d. Perform a follow-up thermographic survey within 12 months of final acceptance by the owner.

2.3 TEST REPORTS

A. The test report shall include the following:

1. Summary of project.

2. Description of equipment tested.

3. Description of test.

4. Test data.

5. Analysis and recommendations.

B. Test data records shall include the following minimum requirements:

1. Identification of the testing organization.

2. Equipment identification.

3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.

4. Date of inspections, tests, maintenance, and/or calibrations.

5. Identification of the testing technician.

6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.

7. Indication of expected results when calibrations are to be performed.

8. Indication of “as-found” and “as-left” results.

9. Sufficient spaces to allow all results and comments to be indicated.

C. The testing firm shall furnish a copy or copies of the complete report to the owner as required in the acceptance contract.

TABLE 100.18

THERMOGRAPHIC SURVEY
SUGGESTED ACTIONS BASED ON TEMPERATURE RISE

Temperature difference (ΔT) based on comparisons between similar components under similar loading.	**Temperature difference (ΔT) based upon comparisons between component and ambient air temperatures.**	**Recommended Action**
1ºC - 3ºC	1ºC - 10ºC	Possible deficiency; warrants investigation
4ºC - 15ºC	11ºC - 20ºC	Indicates probable deficiency; repair as time permits
- - - - - -	21ºC - 40ºC	Monitor until corrective measures can be accomplished
>15ºC	>40ºC	Major discrepancy; repair immediately

Temperature specifications vary depending on the exact type of equipment. Even in the same class of equipment (i.e., cables) there are various temperature ratings. Heating is generally related to the square of the current; therefore, the load current will have a major impact on ΔT. In the absence of consensus standards for ΔT, the values in this table will provide reasonable guidelines.

An alternative method of evaluation is the standards-based temperature rating system as discussed in Chapter 8.9.2, Conducting an IR Thermographic Inspection, *Electrical Power Systems Maintenance and Testing*, by Paul Gill, PE, 1998.

It is a necessary and valid requirement that the person performing the electrical inspection be thoroughly trained and experienced concerning the apparatus and systems being evaluated as well as knowledgeable of thermographic methodology

PART 3 -- TEST RECORD SHEETS

The test record sheets listed below shall be used to record testing of electrical equipment and of the electrical installation as required by these specifications. Sample copies of each sheet are attached.

Sheet No.	Title
1	Insulation Resistance (Power, Control Wire, and Cable) Test Record
2	Insulation Resistance (Instrument Wire and Cable) Test Record
3	DC High Potential (Medium Voltage Cable) Test Record
4	Ground Electrode Testing Test Record
5	Neutral Grounding Resistor Test Record
6	Bonding Resistance Readings (Nonelectrical Equipment/Structures) Test Record
7	Bonding Resistance Readings (Electrical Equipment) Test Record
8	Insulation Resistance (Transformer) Test Record
9	Insulation Resistance (Equipment) Test Record
10	Insulation Resistance (Rotating Equipment) Test Record
11	Equipment Absorption Ratio and Polarization Index Test Record
12	Electric Motor Run-In Test Record
13	Thermographic Test Record

INSULATION RESISTANCE
(POWER, CONTROL WIRE, AND CABLE)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: ___ ºC _____ ºF DATE: _____

NOTES: 1. Perform Insulation Resistance Test (megger) between each conductor and all other conductors and metallic sheath for cables with nonshielded conductors. Test between each conductor and shield for multiconductor cables with shielded conductors. Record lowest reading for each cable.

2. Use 1,000-V test set for cable rated 600 volts and 2,500-V test set for cable rated over 600 volts.

3. Readings will vary inversely with temperature and cable length. When the use of temperature correction factors is specified, attach a second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Panel No. Circuit No. Feeder No.	Wire Tagging	Cable Rated Voltage	Wire or Cable Quantity	Insulation Size	From	To	Resistance (megohms)*	Initials

*Minimum acceptable values:

Cable Rated Voltage	Test Duration	Resistance for Cable Only	Cable/Wire Size or Amperage (megohms)	Resistance When Cable Connected to Equipment (ohms)

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE
(INSTRUMENT WIRE AND CABLE)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

NOTES: 1. Record only the lowest value.

2. MP - Multi-pair cable. SP - Single pair cable.
3. Megger with instruments disconnected.
4. Use 250 volt (or lower voltage, when specified) range on DC test set.
5. Readings will vary with temperature and cable length.*

Cable Number or Instrument Number	Indicate MP or SP Type (2)	Conductor to Conduit (Single Pair Non-Shielded Cables) (megohms)	Conductor to Conductor (megohms) (1)	Shield to Conductor to Shield (megohms) (1)	Overall Shield to Shield (Multipair Cables Only) (megohms) (1)	Lead and Armor (Multipair Cables Only (megohms)	Shield to Conduit (Single Pair Cables Only) (megohms)	Initials

DISTRIBUTION:

CONTRACTOR/Date _____

DC HIGH POTENTIAL (MEDIUM VOLTAGE CABLE)
TEST RECORD

CIRCUIT NUMBER: _____ REF. DWG.: _____

CABLE SIZE: _____ (SQ.MM.) _____ (MCM) FROM: _____ TO: _____

NUMBER OF CONDUCTORS: _____ NO. OF SPLICES: _____

CABLE LENGTH: _____ MANUFACTURER: _____

INSULATION TYPE: _____ THICKNESS: _____

JACKET MATERIAL: _____

WEATHER: _____TEMP.:_____ºC_____ºF % HUMIDITY: _____DATE: _____

TEST EQUIPMENT USED: _____

NOTES:

1. The test voltage shown below shall be reached in 10 equal voltage increments.
2. After each voltage increase, the leakage current shall be allowed to stabilize during a 1-minute interval. If 1-minute intervals are insufficient to stabilize the current, the cable shall be discharged, and the test repeated with new time intervals of greater, but still equal duration.
3. Record the stabilized leakage current, in microamps, at the end of each time interval.
4. Allow the voltage to remain constant at the full test voltage and record the leakage current for 5 minutes for unshielded cables and 15 minutes for shielded cables.
5. Read test equipment instruction manual prior to testing cable.
6. When the plotting of test results is specified, attach the second sheet with separate plot for each phase. Note leakage current, in microamps, on “y” axis. Note step-voltage increase on “x” axis, followed by time, in minutes, for the dielectric absorption portion of the test.
7. All other phases and shields to be grounded.

Voltage hold time at each step _____ sec.	____k V	____k V	____k V	____k V	____k V	____k V	____k V	____k V	____k V	____k V
ØA[7]										
ØB[7]										
ØC[7]										

RECORD LEAKAGE CURRENT IN MICROAMPS

Time at _____Kv	SEC 30	MIN 1	MIN 2	MIN 3	MIN 4	MIN 5	MIN 6	MIN 7	MIN 8	MIN 9	MIN 10	MIN 11	MIN 12	MIN 13	MIN 14	MIN 15

CABLE-RATED VOLTAGE
(kilovolts)

TEST VOLTAGE
(kilovolts)

DISTRIBUTION:

CONTRACTOR/Date _____

GROUND ELECTRODE TESTING
TEST RECORD

TEST EQUIPMENT: _____ (Note 1) _____ (Note 2)

REFERENCE DRAWING: _____ _____

NOTES: 1. Record resistance-to-earth for each electrode with all other conductors disconnected. Resistance not to exceed 25 ohms for any single anode.

2. Check continuity from each electrode to any test bar or other electrode such that the complete ground loop is tested.

Rod Number	Resistance to Earth (ohms)	Ambient Temperature (ºC/ºF)	Weather	Taps (□)	Initials/Date

DISTRIBUTION:

CONTRACTOR/Date _____

NEUTRAL GROUNDING RESISTOR
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

NOTES:
1. Use 1,000-volt test set for 600-volt equipment and below, 2,500-volt test set for equipment rated over 600 volts.
2. Resistor must be disconnected from ground and neutral during Insulation Resistance (megger) and DC Overpotential Tests.
3. Resistor must be disconnected from neutral during Cold Resistance Test.
4. Apply DC Overpotential Test between terminals and ground for the complete device. (The voltage applied between the terminals of each assembly and its grounded enclosure shall be twice the rated AC voltage plus 1000 V when rated 600 V or less, or 2.25 times the rated AC voltage plus 2000 V when rated over 600 V for 1 minute. This test is a Pass/Fail test based purely on withstand alone.
5. Inspect assembly for damage and missing parts.
6. Check to assure that the center tap ratio is correct, when CT is supplied with resistor.
7. Verify resistor reterminated.

Tag. No.	Cold Res. (ohms)	Insul. Res. (megohms)*	Overpot. (□)	CT Ratio Pri-Sec	Reterm (□)	Initials/Date

*Minimum acceptable values:

VOLTAGE CLASS	INSULATION RESISTANCE (megohms)

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS
(NONELECTRICAL EQUIPMENT/STRUCTURES)
TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Vessels, tanks, and structural steel bonded to the main grounding system, dedicated ground rod or foundation, as indicated on drawings listed below.

2. Measure resistance from ground wire tap (or anchor bolt) to tagged equipment frame or structural steel.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

CONTRACTOR/Date _____

BONDING RESISTANCE READINGS
(ELECTRICAL EQUIPMENT)
TEST RECORD

TEST EQUIPMENT USED: _____ WEATHER: _____

NOTES: 1. Electrical equipment bonded to the main grounding system or dedicated ground rod, as indicated on drawings listed below.

2. Measure resistance from ground wire tap to tagged equipment bus bars, tagged equipment enclosures, and any other points indicated on the drawings.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE
(TRANSFORMER)
TEST RECORD

SUBSTATION NO.: _____ TEST EQUIPMENT: _____

NOTES:
1. Use 1,000-V test set for 600-volt equipment and below, 2,500-V test set for equipment rated 601 - 5,000 volts, and 5,000-V test set for equipment rated over 5,000 volts.
2. Test voltage to be applied for 1-minute duration, and reading taken.
3. Neutral must be disconnected from ground during test.
4. Record temperature of surrounding air temperature for dry-type transformers.
5. Readings will vary inversely with temperature. When the use of temperature correction factors is specified, attach second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Equipment Tag No.	RESISTANCE IN (megohms) *						Pri to Sec	Voltage Rating (kV)	Pri-Sec or Air	Liquid Temp. (ºC/ºF)
	Primary			Secondary						
	∅A to G	∅B to G	∅C to G	∅A to G	∅B to G	∅C to G				

*Minimum acceptable values:

VOLTAGE CLASS	RESISTANCE (megohms)

TESTER'S INITIALS/DATE _____

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE (EQUIPMENT)
TEST RECORD

TEST EQUIPMENT: _____ SUBSTATION: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

REFERENCE DRAWING: _____ REF. SEC.: _____

NOTES: 1. Use 1,000-V test set for equipment rated 600 volts and below, 2,500/5,000-V test set for equipment rated over 600 volts.

2. For equipment with solid state control circuits, consult manufacturer's literature for maximum test voltages.

Switchgear MCC (other)	INSULATION RESISTANCE (megohms) *						Test Voltage (kV)	Rated Voltage (kV)	Initials/ Date
	∅A to G	∅B to G	∅C to G	∅A to ∅B	∅B to ∅C	∅C to ∅A			

*Minimum acceptable values:

EQUIPMENT VOLTAGE CLASS (megohms)	RESISTANCE

TESTER'S INITIALS/DATE _____

DISTRIBUTION:

CONTRACTOR/Date _____

INSULATION RESISTANCE (ROTATING EQUIPMENT)
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

EQUIP. TEMP., IF KNOWN: _____ ºC _____ ºF HOW KNOWN: _____

NOTES:
1. Use 1,000-V test set for equipment 600-volt and below, 2,500/5,000-V test set for equipment rated over 600 volts.
2. Test duration shall be 1 minute, note if otherwise: _____.
3. Isolate all motor leads from one another and from frame, test phase separately, wherever practical.
4. Document testing of low voltage and medium voltage equipment on separate sheets.
5. Readings will vary inversely with temperature. When the use of temperature correction factors is specified, attach second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Equipment Tag No.	INSULATION RESISTANCE (megohms) *						Rated Voltage	Equipment Initial/Date
	∅A to G	∅B to G	∅C to G	∅A to ∅B	∅B to ∅C	∅C to ∅A		

*Minimum acceptable values:

VOLTAGE CLASS	RESISTANCE (megohms)

DISTRIBUTION:

CONTRACTOR/Date _____

EQUIPMENT ABSORPTION RATIO
AND POLARIZATION INDEX
TEST RECORD

TEST EQUIPMENT: _____ TEST VOLTAGE: _____

AMBIENT TEMPERATURE: _____ ºC _____ ºF DATE: _____

EQUIP. TEMP., IF KNOWN: _____ ºC _____ ºF REL. HUMIDITY: _____

NOTES: 1. Perform test as indicated on Test Records for each individual equipment type. Reference the following sheets:

Transformers	8
Equipment	9
Motors and Generators	10

2. Absorption Ratio = $\frac{\text{1-Minute Resistance Value}}{\text{30-Second Resistance Value}}$

3. Polarization Index = $\frac{\text{10-Minute Resistance Value}}{\text{1-Minute Resistance Value}}$

OHMS TO GROUND 30-SECOND READING ∅A TO GROUND	OHMS TO GROUND 1-MINUTE READING ∅A TO GROUND	OHMS TO GROUND 10-MINUTE READING ∅A TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX
OHMS TO GROUND 30-SECOND READING ∅B TO GROUND	OHMS TO GROUND 1-MINUTE READING ∅B TO GROUND	OHMS TO GROUND 10-MINUTE READING ∅B TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX
OHMS TO GROUND 30-SECOND READING ∅C TO GROUND	OHMS TO GROUND 1-MINUTE READING ∅C TO GROUND	OHMS TO GROUND 10-MINUTE READING ∅C TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX

TESTER'S INITIALS/DATE _____

DISTRIBUTION:

CONTRACTOR/Date _____

ELECTRIC MOTOR RUN-IN
TEST RECORD

TEST EQUIPMENT: _____ REFERENCE DRAWING: _____

NOTES: 1. Duration of tests to comply with specifications.

TEST	REMARKS	INITIALS/DATE
RESISTANCE: Bonding resistance measured from motor frame to main ground/earth system tap. _____ ohms		
VOLTAGE: Actual voltage measured at Motor Control Center. _____ volts		
ROTATION CHECK: Bump motor to verify rotation. Motor to be uncoupled.		
NO LOAD CURRENT: At beginning of test _____ amps At end of test _____ amps		
TEMPERATURE OF BEARING: Check bearing for high temperature: Before start: 15 minutes after start 30 minutes after start 1 hour after start 2 hours after start 3 hours after start		
VIBRATION: Make visual inspection during run-test. Record any unusual vibration in remarks column.		
NOISE: Record any unusual noise in remarks column.		

DISTRIBUTION:

CONTRACTOR/Date _____

THERMOGRAPHIC INSPECTION
TEST RECORD

EQUIPMENT: _____

THERMAL AND ELECTRICAL INFORMATION

THERMAL DATA (°F/°C) AND RISE				MANUAL READINGS			
A Phase	____/____	Reference	_____°F	A Phase	_____ A	A/ B Volts	_____V
B Phase	____/____	Temperature	_____° C	B Phase	_____ A	B/C Volts	_____V
C Phase	____/____	ΔT	_____°F	C Phase	_____ A	A/C Volts	_____V
Neutral	____/____	or Rise	_____° C	Neutral	_____ A	A/N Volts	_____V
ANOMALY TEMP(°F/°C)							
PROBLEM DESCRIPTION:							
RECOMMENDATION:							

ANOMALY PRIORITY

CRITICAL - IMMEDIATE ATTENTION SUGGESTED

SEVERE - PROBABLE FAILURE, PROMPT ACTION RECOMMENDED

INTERMEDIATE - MONITOR PROBLEM, SCHEDULE MAINTENANCE

MINOR - SCHEDULE ROUTINE MAINTENANCE AT NEXT OPPORTUNITY

DISTRIBUTION:

CONTRACTOR/Date _____

END OF SECTION

SECTION 26 05 15 – INDUSTRIAL CONTROL PANELS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide complete industrial control panels and/or local control stations as indicated herein or in other Sections of the Specifications. The stations shall be designed to provide the sequence of operation in Section 40 91 00 – Process Control Instrumentation Systems and the P&ID Drawings.

B. This section also specifies miscellaneous electrical devices used throughout this project. These devices are not limited to use within industrial control panels or local control stations.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Industrial control panels and/or local control stations shall comply with the requirements of NEC (including Article 409), NEMA, and UL.

1.3 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings in accordance with Sections 01 33 00 – Submittal Procedures and 26 00 00 – Electrical Work, General.

1. Ladder diagrams and written descriptions explaining ladder diagram operation and system operation.

2. Include catalog cuts of control equipment including enclosures, overcurrent devices, relays, pilot devices, terminations, and wire troughs.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The Contractor shall provide the equipment, panels and stations to satisfy the functional requirements in the relevant mechanical equipment and Instrumentation and Control specifications and the Electrical Elementary Schematics. Each panel and station shall be fabricated with UL labeled components. Equipment not specifically indicated as being WORK of other Sections shall be provided under this Section. All equipment, panels and stations shall be wired under this Section.

B. The controls shall be 120 V maximum. Where the electrical power supply is 240 V, single phase or 480 V, 3 phase, the station shall be provided with a fused control power transformer. Control conductors shall be provided in accordance with Section 26 05 19 – Wire and Cabling.

C. Each panel and/or station shall be provided with identified terminal strips for the connection of external conductors. The Contractor shall provide sufficient terminal

blocks to connect 25 percent additional conductors for future use. Termination points shall be identified in accordance with Shop Drawings. The panels and/or stations shall be the source of power for all 120 VAC solenoid valves interconnected with the panels and/or stations. Equipment associated with the panels and/or stations shall be ready for service after connection of conductors to equipment, controls, panels and/or stations.

D. Wiring to door-mounted devices shall be extra flexible and anchored to doors using wire anchors cemented in place. Exposed terminals of door-mounted devices shall be guarded to prevent accidental personnel contact with energized terminals.

E. Enclosures

1. NEMA 12 steel enclosures shall be painted with ANSI 61 exterior and white interior.

2. NEMA 4X enclosures shall be stainless steel with brushed finish. Where possible, penetrations shall be made in such a manner to maintain the NEMA 4X rating. If this is not possible, the penetrations shall be made in such a manner to minimize entry of foreign materials into the enclosure, subject to approval by the Engineer.

3. In chemical areas for alum, sodium hypochlorite, etc., NEMA 4X fiberglass enclosures shall be used.

4. Enclosures shall be freestanding, pedestal-mounted, or equipment skid-mounted, as indicated. Internal control components shall be mounted on a removable mounting pan. Mounting pan shall be finished white.

5. Outdoor mounted enclosures shall be provided with thermostatically-controlled heaters with fan, Hoffman, or equal.

6. Provide screened weep holes for draining condensation.

F. Disconnect Switches

1. Heavy duty, circuit breaker type or non-fusible as shown, single throw switches shall be rated not less than 65 KA at 480 VAC.

2. Horsepower rated

3. UL listed

4. Padlockable in "Off" position and door interlock

5. Enclosure per area classification in Section 26 00 00 – Electrical Work, General.

6. 480 V, 3-phase, 3-pole (6-pole when used with 2-speed motor).

7. Auxiliary control contact as indicated or required.

8. As manufactured by **G.E., Eaton Electrical, Square D,** or equal.

G. Identification of panel-mounted devices, conductors, and electrical components shall be in accordance with Section 26 00 00 – Electrical Work, General.

H. Panel-mounted devices shall be mounted a minimum of 3-feet above finished floor elevation, but not higher than 6’-6” above finished floor, unless noted otherwise.

2.2 PANEL/STATION COMPONENTS

A. Pushbuttons, selector switches, and pilot lights shall be the heavy-duty, oil-tight type, sized to 30-mm. Miniature style devices are not acceptable. Devices shall be as manufactured by **General Electric, Eaton Electrical, Square D,** or equal.

1. Lens colors shall be red for "run," "open," or "on"; green for "stopped," "closed," or "off"; and amber for alarm.

2. Pilot lights shall be full voltage, push-to-test, light emitting diode (LED) type.

3. Provide hazardous location type pilot devices in classified locations.

B. Relays shall be 3 PDT with 10 amp contacts, plug-in type with indicating light, rectangular blades and provided with sockets for screw-type termination and hold-down clips. Relays shall be as manufactured by **Square D, Potter Brumfield,** or equal.

C. Elapsed time meters shall be non-resettable type, read to a maximum of 99999.9 hours and shall be as manufactured by **General Electric, Eaton Electrical,** or equal.

D. Magnetic starters shall be:

1. NEMA rated, Size 1 minimum. IEC or dual NEMA/IEC rated type are not acceptable.

2. Control transformers shall be provided with primary and secondary fuses, 120 V maximum control voltage. VA rating of transformer shall be based on devices on the control schematic.

E. Terminal strips shall be provided for every panel and shall be the flanged fork or ring lug type suitable for No. 12 AWG stranded wire minimum. Provide 25 percent spare terminals in each panel.

2.3 FACTORY TESTING

A. Each panel/station shall be factory assembled and tested for sequence of operation prior to delivery.

2.4 SPARE PARTS

A. Provide a minimum of 10 percent spare lamps (minimum 2) and one spare lens for each color pilot lamp in each panel.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Panels/stations shall be installed in accordance with Section 26 00 00 – Electrical Work, General and in accordance with the manufacturer's recommendations.

B. Panels/stations shall be protected at the site from loss, damage, and the effects of weather. Panels/stations shall be stored in an indoor, dry location. Heating shall be provided in areas subject to corrosion and humidity.

C. Panels/station interiors and exteriors shall be cleaned, and coatings shall be touched up to match original finish upon completion of the WORK.

D. Conduit, conductors, and terminations shall be installed in accordance with Section 26 00 00 – Electrical Work, General.

3.2 FIELD TESTING

A. Each panel/station shall be tested again for functional operation in the field after the connection of external conductors and prior to equipment startup.

END OF SECTION

SECTION 26 05 19 - WIRE AND CABLING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide wire and cable, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 ACTION SUBMITTALS

A. The Contractor shall submit Shop Drawings in accordance with Sections 01 33 00 – Submittal Procedures and 26 00 00 – Electrical Work, General. Submit cable test results in accordance with this Section as well as Section 26 01 26 – Electrical Tests.

1.4 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall protect all cables from damage at all times.

B. Cable ends shall be protected from water entry in accordance with the manufacturer’s recommended procedures. Cable ends shall not be left open in manholes or other locations subject to submergence. If the cable ends become submerged prior to splicing or termination, the cables shall be replaced in their entirety.

C. Cables shall be pulled into raceways in accordance with the manufacturer’s requirements. Under no circumstances shall cable pulling tensions exceed the manufacturer’s written instructions.

D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor and/or solid conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.

B. Low Voltage Power and Lighting Wire

1. Wire rated for 600 volts in duct or conduit for power and lighting circuits shall be single conductor, Class B Type XHHW or XHHW-2 cross-linked polyethylene conforming to UL-44 - UL Standard for Thermoset-Insulated Wires and Cables. THHN/THWN wire shall not be permitted to be used for any power or control wiring in this project, except as specifically permitted within control panels per Section 26 05 15 – Industrial Control Panels.

2. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

3. 3. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

4. Wiring for 600-volt class power and lighting shall be as manufactured by **Okonite**, **General Cable**, **Southwire**, or equal.

C. Low Voltage Control Wire

1. Low voltage control wire in duct or conduit shall be the same type as power and lighting wire indicated above.

2. Control wiring shall be No.14 AWG.

3. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations, and be as manufactured by **American, General Cable,** or equal.

D. Instrumentation Cable

1. Instrumentation cable shall be rated at 300 volts, minimum.

2. Individual conductors shall be No. 16 AWG stranded, tinned copper. Insulation shall be color coded polyethylene: black-clear for 2 conductor cable and black-red-clear for 3 conductor cable.

3. Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 18 or larger AWG stranded, tinned copper drain wire, and a PVC outer jacket with a thickness of 0.047-inches.

4. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 8719,** similar by **General Cable,** or equal.

5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 8618,** similar by **General Cable,** or equal.

E. VFD Power Cable

1. VFD power cable shall be three (3) conductor, stranded copper, PVC jacketed, shielded type, tray cable (TC) rated 600 volts with three (3) symmetrical ground conductors. The individual conductors shall be UL listed as Type XHHW-2 or RWH-2 rated for 90 degrees C at wet and dry locations, with XLPE insulation.

2. VFD Cables shall be as manufactured by **Belden, Alpha**, **General Cable,** or equal.

F. Medium Voltage Cable - General

1. Individual conductors shall be copper, Class B, stranded.

G. Medium Voltage -15 KV Cable

1. Cable used in conduit or duct shall be composed of a single conductor, ethylene-propylene rubber (EPR) insulation rated at 105 degrees C, shield and black polyvinyl chloride (PVC) outer jacket. Insulation level shall be 133 percent. Shield shall be copper tape type, or corrugated drain wire type. Cable shall be UL Type MV-105 in accordance with UL 1072 and ICEA-S-93-639/NEMA-WC74 as manufactured by **Okonite, Southwire**, **General Cable,** or equal.

H. Cable Splices and Terminations

1. Where cable lugs are required for power cable terminations, utilize compression lugs – **3M** Scotchlok 30000 and 31100 Series, **Penn Union** HBBLU and BLU, **Burndy** Hylug, or equal. Utilize compression tools as recommended by the manufacturer. Pressure type, twist-on connectors (wire nuts) will not be acceptable.

2. Pre-insulated fork tongue lugs shall be **Thomas & Betts, Burndy**, or equal.

3. General purpose insulating tape shall be **Scotch No. 33**, **Plymouth Slip-knot**, or equal. High temperature tape shall be polyvinyl as manufactured by **Plymouth, 3M,** or equal.

4. Labels for coding 600-volt wiring shall be computer printable or pre-printed, self-laminating, self-sticking, as manufactured by **W.H. Brady, 3M**, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The Contractor shall provide, terminate and test all power, control, and instrumentation conductors.

B. The Contractor shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares for future use.

C. Conductors shall not be pulled into any raceway until raceway has been cleared of moisture and debris.

D. Instrumentation wire shall not be run in the same raceway with power and control wiring except where specifically indicated.

E. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be neatly fanned out to terminals.

3.2 FIELD ASSEMBLY

A. General

1. Wire taps and splices shall be properly taped and insulated according to their respective classes.

2. In general, there shall be no cable splices. If splices are necessary, the cables shall be spliced using submersible cable splices, suitable for continuous submergence. Splices in below grade may be made only with the approval of the Engineer.

3. Stranded conductors shall be terminated directly on equipment box lugs making sure that conductor strands are confined within lug. Use forked-tongue lugs where equipment box lugs have not been provided.

4. Excess control and instrumentation wires shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin, and be neatly coiled.

B. Control Wire and Cable

1. Control conductors shall be spliced or terminated only at the locations indicated and only on terminal strips or terminal lugs of vendor furnished equipment.

2. In control panels, control wire and spare wire shall be terminated to terminal strips.

3. The Contractor shall provide as a minimum the number of control wires listed in the conduit schedule or as indicated in the Contract Documents. Excess wires shall be treated as spares.

C. Instrumentation Wire and Cable

1. Shielded instrumentation cables shall be grounded at one end only, preferably the receiving end on a 4 - 20 mA system.

2. Two and 3 conductor shielded cables installed in conduit runs which exceed available standard cable lengths may be spliced in pullboxes with the prior approval of the Engineer. Such cable runs shall have only one splice per conductor.

D. Power Wire and Cable

1. 120/208-volt, 120/240-volt, and 480/277-volt branch circuit conductors may be spliced in suitable fittings at locations determined by the Contractor. Cables rated above 2,000 volts shall be spliced or terminated only at equipment terminals indicated.

2. Splices to motor leads in motor terminal boxes shall be wrapped with mastic material to form a mold and then shall be taped with a minimum of 2 layers of varnished cambric tape overtaped with a minimum of 2 layers of high temperature tape.

3. Shielded power cable shall be terminated with pre-assembled stress cones in a manner approved by the cable and terminal manufacturer. The Contractor shall submit the proposed termination procedure as a Shop Drawing.

4. VFD shielded power cables shall have the shield grounded at all locations where it is exposed.

E. Cable Identification

1. General: Wire and cable shall be identified for proper control of circuits and equipment and to reduce maintenance effort. Identification shall be installed at every termination point.

2. Identification Numbers: The Contractor shall assign to each control and instrumentation wire and cable a unique identification number. Numbers shall be assigned to conductors having common terminals and shall be shown on "as built" drawings. Identification numbers shall appear within 3-inches of conductor terminals. "Control and Instrumentation Conductors" shall be defined as any conductor used for control, interlock, alarm, annunciator, or signal purposes.

   a. Multiconductor cable shall be assigned a number which shall be attached to the cable at intermediate pull boxes and at stub-up locations beneath free-standing equipment. It is expected that the cable number shall form a part of the individual wire number. Individual control conductors and instrumentation cable shall be identified at pull points as described above. The instrumentation cable numbers shall incorporate the loop numbers assigned in the Contract Documents.

   b. 120/208-volt system feeder cables and branch circuit conductors shall be color coded as follows: Phase A - black, Phase B - red, Phase C - blue, and Neutral - white. The 480/277-volt system conductors shall be color coded as follows: Phase A - Brown, Phase B - Orange, Phase C - Yellow, and Neutral - Gray. Branch circuit switch shall be yellow. Insulated ground wire shall be green, and neutral shall be gray. Color coding and phasing shall be consistent throughout the Site, but bars at panelboards, switchboards, and motor control centers shall be connected Phase A-B-C, top to bottom, or left to right, facing connecting lugs. Color coding tape shall be used where colored insulation is not available. Colored identification tape may be used on conductors between the local disconnect and the load, where permitted by the NEC. Any phase changes necessary for proper rotation shall be made at the driven equipment where colored insulation is used. Phase changes may be made on the load side of the local disconnect, where phase colors are identified using tape.

   c. General purpose AC control cable shall be red. General purpose DC control cable shall be blue.

   d. Spare cable shall be terminated on terminal screws and shall be identified with a unique number as well as with destination.

   e. Terminal strips shall be identified by computer printable, cloth, self-sticking marker strips attached under the terminal strip.

3.3 FIELD QUALITY CONTROL

A. Cable Assembly and Testing: Cable assembly and testing shall comply with applicable requirements of ICEA Publication No. S-95-658/NEMA WC70 - Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy. Factory test results shall be submitted in accordance with Section 01 33 00 – Submittal Procedures, prior to shipment of cable. The following field tests (in addition to the tests specified in Section 26 01 26 – Electrical Tests) shall be the minimum requirements:

1. Insulation resistance testing, using a DC megohmeter, shall be performed on cables operating at more than 2,000 volts to ground. Time-resistance readings shall be taken and recorded at intervals of 30 seconds and one minute. Time-resistance voltage levels shall be per the cable manufacturer's recommendations.

2. Power cable rated at 600 volts shall be tested for insulation resistance between phases and from each phase to a ground using a megohmeter.

3. Field testing shall be done after cable is installed in the raceways.

4. Field megger testing may be performed by the Contractor or a NETA-certified test organization. When tested by the Contractor, submit test equipment calibration sheets prior to performing any field testing. Test results shall be submitted to the Engineer for review and acceptance.

5. Cables failing the tests shall be replaced with a new cable or be repaired. Repair methods shall be as recommended by the cable manufacturer and shall be performed by persons certified by the industry.

B. Continuity Test: Control and instrumentation cable shall be tested for continuity, polarity, undesirable ground, and origination. Such tests shall be performed after installation and prior to placing cable in service.

END OF SECTION

SECTION 26 05 26 – GROUNDING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide the electrical grounding system, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 ACTION SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures and Section 26 00 00 – Electrical Work, General.

1. Include with each submittal a copy of this specification section, with addenda updates included, and all referenced and applicable sections included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

B. Shop Drawings

1. Submit manufacturer's product information for connectors, clamps, and all grounding system components, showing compliance with the requirements of this Section.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Components of the grounding electrode system shall be manufactured in accordance with UL 467 - Standard for Safety Grounding and Bonding Equipment and shall conform to the applicable requirements of National Electrical Code Article 250 and local codes.

B. Grounding System

1. Grounding loop conductors shall be bare annealed copper conductors.

2. Ground ring and main branch conductors shall be No. 4/0 unless indicated otherwise.

3. Ground Rods

a. Unless indicated otherwise, provide ground rods minimum of 3/4 inch in diameter, 10 feet long, and with a uniform covering of electrolytic copper metallically bonded to a rigid steel core.

b. Provide corrosion-resistant copper-to-steel bond.

c. The rods shall conform to UL 467.

d. The rods shall be of the sectional type, joined by threaded copper alloy couplings.

4. Make buried, concrete-encased, or otherwise inaccessible cable-to-cable and cable-to-ground rod connections using exothermic welds by **Cadweld, Thermoweld,** or equal.

5. Exposed Connectors

a. Exposed grounding connectors shall be of the compression type (connector-to-cable), constructed of high-copper alloy, and manufactured specifically for the particular grounding application.

b. The connectors shall be **Burndy, O.Z. Gedney**, or equal.

6. Use grounding clamps to bond each separately-derived system to the grounding electrode conductors.

7. Equipment Grounding Circuit Conductors

a. The conductors shall be the same type and insulation as the load circuit conductors.

b. The minimum size shall be as indicated. Where not indicated, sizes shall conform to Table 250.122 of the National Electrical Code.

c. Metallic conduit systems shall have an equipment grounding wire as well as being equipment grounding conductors themselves.

8. Grounding Materials Manufacturer, or Equal

a. Copperweld

b. Thermoweld

c. Burndy

d. Thomas and Betts

e. OZ Gedney

PART 3 -- EXECUTION

3.1 PREPARATION

A. Provide a separate grounding conductor, securely grounded in each raceway independent of raceway material.

B. Provide a separate grounding conductor for each motor and connect at motor box. Provide a supplemental ground connection for motor shaft grounding rings, where applicable.

C. Do not use bolts for securing the motor box to the frame or the cover for grounding connectors.

D. Sizes shall be as indicated on the Conduit Schedule and in accordance with NEC Article 250.

E. Route the conductors inside the raceway.

F. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.

G. Individually bond the raceway to the ground bus in the secondary section.

H. Provide a green insulated wire as grounding jumper from the ground screw to a box grounding screw, and, for grounding type devices, to the equipment grounding conductor.

I. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.

J. Interconnect the secondary switchgear MCC or panelboard neutral bus to the ground bus in the secondary switchgear compartment only at the service entrance point. For wye connected, 3 phase, separately derived systems with 3 wire distribution, connect the transformer neutral to the grounding electrode system at the transformer. Connections shall be in accordance with the NEC.

K. Provide the duct bank ground system as indicated, including trenching, splices, ground rods, and connections to equipment and structures.

L. Measure ground impedance in accordance with IEEE STD 81 after installation but before connecting the electrode to the remaining grounding system. Provide additional grounding system testing in accordance with Section 26 01 26 – Electrical Tests.

M. Low Voltage Grounded System (600V or less)

1. A low-voltage grounded system is defined as a system where the local power supply is a transformer, with the transformer secondary grounded.

2. Grounding system connections for a premises-wired system supplied by a grounded AC service shall be provided with a grounding electrode connector connected to the grounded service conductor at each service, in accordance with the NEC.

3. The grounded circuit conductor shall not be used for grounding non-current-carrying parts of equipment, raceways, and other enclosures except where specifically listed and permitted by the NEC.

N. Embedded Ground Connections

1. Underground and grounding connections embedded in concrete shall be UL-listed ground grid connectors.

2. The connection shall be made in accordance with the manufacturer's instructions.

3. Do not conceal or cover ground connections until the Engineer or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the Contractor written confirmation.

O. Ground Ring

1. Furnish trenching and materials as necessary to install the ground ring as indicated.

2. The bonding conductor shall be in direct contact with the earth and of the indicated size.

3. Provide a minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.

4. Re-compact disturbed soils to their original density in 6-inch lifts.

P. Duct Bank Ground

1. Embed a grounding conductor in every duct bank as indicated. The ground conductor shall be terminated at the ground grid at each end of the duct bank. Where no ground grid is installed, terminate at a suitable grounding electrode conductor near the end of the duct bank in accordance with the NEC.

Q. Ground Rods

1. Provide ground rods at the indicated locations.

2. A single electrode that does not have resistance-to-ground of 5 ohms or less shall be augmented by additional electrodes to obtain this value.

3. Take the resistance-to-ground measurement during dry weather, a minimum of 48 hours after a rainfall.

4. Rods forming an individual ground array shall be equal in length.

R. Instrumentation Shield Grounding

1. Shielded instrumentation cable shall have its shield grounded at one end only unless the approved Shop Drawings indicate that the shield will be grounded at both ends.

2. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable.

3. The termination of the shield drain wire shall be on its own terminal screw.

4. Jumper together the terminal screws, using manufactured terminal block jumpers or a No. 14 green insulated conductor.

5. Connect the ground bus via a green No. 12 conductor to the main ground bus for the panel.

END OF SECTION

SECTION 26 05 33 - ELECTRICAL RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide electrical raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.

2. As-Built Drawings

a. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

b. Furnish the drawings to the Engineer in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Pull and junction boxes, fittings, and other indicated enclosures that are dedicated to the raceway system shall comply with the requirements of this Section.

2.2 CONDUIT

A. Rigid Galvanized Steel (RGS) Conduit

1. Provide rigid steel conduit manufactured from mild steel, hot-dip galvanized inside and out.

2. Provide rigid steel conduit manufactured in accordance with NEMA C80.1 – Electrical Rigid Steel Conduit, and UL-6 – Electrical Rigid Metal Conduit - Steel.

3. Manufacturer, or Equal

    a. **Allied Tube & Conduit**

    b. **Triangle**

    c. **Wheatland Tube**

B. PVC Rigid Non-Metallic Conduit

1. Provide rigid non-metallic conduit manufactured from Schedule 40 or Schedule 80 PVC, as indicated, and sunlight-resistant.

2. Provide rigid non-metallic conduit manufactured in accordance with NEMA TC-2 - Electrical Plastic Tubing and Conduit, and UL-651 - Standard for Rigid Non-metallic Conduit.

3. Manufacturer, or Equal

    a. **Carlon**

    b. **Cantex**

C. Rigid PVC-Coated Galvanized Steel (RPGS) Conduit

1. The conduit shall meet the requirements for RGS conduit as indicated above.

2. Bond a PVC coating to the outer surface of the galvanized conduit.

3. Ensure that the bond between the coating and the conduit surface is greater than the tensile strength of the coating.

4. Provide the inside surfaces and threads of the conduit with a 2-mil urethane coating.

5. Provide a PVC coating thickness not less than 40 mils.

6. The PVC-coated RGS shall be manufactured in accordance with the following standards:

    a. UL-6

    b. ANSI C80.1

    c. NEMA RN1 - PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

7. Manufacturer, or Equal

    a. **Robroy Industries**

    b. **O'Kote**

c. **Thomas & Betts**

D. Liquid-Tight Flexible Conduit

1. Provide liquid-tight flexible conduit constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket.

2. Provide liquid-tight flexible conduit manufactured in accordance with the requirements of UL-360 - Steel Conduits, Liquid-Tight Flexible.

3. Manufacturer, or Equal

a. **Anaconda, Sealtite**

b. **Electriflex, Liquatite**

E. Electrical Metallic Tubing (EMT) or Intermediate conduit (IMC) will not be accepted.

2.3 FITTINGS AND BOXES

A. General

1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.

2. Fittings and Boxes

a. Provide fittings and boxes with neoprene gaskets and non-magnetic stainless steel screws.

b. Attach covers by means of holes tapped into the body of the fitting.

c. Covers for fittings attached by means of clips or clamps will not be accepted.

3. Provide boxes larger than standard cast or malleable types manufactured of Type 304 or Type 316 stainless steel, NEMA 4X.

4. Terminations

a. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, Appleton, or equal.

b. In other than outdoor areas, provide sealed locknuts and bushings.

5. Hazardous Locations

a. In hazardous locations, provide conduit, fittings, and boxes suitable for the indicated Class and Division.

b. Provide conduits terminated in NEMA 7 boxes with a male bushing, **Adalet Type PEM**, or equal, inside the box.

B. Malleable Iron Fittings and Boxes

1. For use with galvanized steel conduit, provide fittings and boxes constructed of malleable iron or gray-iron alloy with zinc plating.

2. Manufacturer, or Equal

    a. **O.Z. Gedney**

    b. **Crouse-Hinds**

    c. **Appleton**

C. PVC Fittings and Boxes

1. For use with rigid non-metallic conduit, provide fittings manufactured of solvent-welded PVC.

2. Provide boxes manufactured of PVC or fiberglass reinforced polyester (FRP).

3. Manufacturer, or Equal

    a. **Carlon**

    b. **Crouse-Hinds**

    c. **Hoffman**

4. Provide welding solvent as required for the installation of non-metallic conduit and fittings.

D. PVC-Coated RGS Fittings

1. For use with PVC-coated RGS, provide PVC-coated coated that are the products of the same manufacturer as the conduit.

2. Provide male and female threads and internal surfaces with a 2-mil urethane coating.

E. Stainless Steel Boxes

1. Provide stainless steel boxes with PVC-coated RGS conduit and where indicated.

2. Provide NEMA 4X stainless steel boxes, constructed of Type 304 stainless steel.

3. Provide stainless steel of a minimum of 14-gauge thickness, with a brushed finish.

4. Door Hinges

    a. Provide doors with full-length stainless steel piano hinges.

    b. Non-hinged boxes will not be accepted.

5. Manufacturer, or Equal

    a. **Hoffman**

b. **Rohn**

c. **Hammond**

F. Sheet Steel Boxes

1. Sheet steel boxes shall be galvanized steel outlet and switch boxes.

2. Manufacturer, or Equal

a. **Raco**

b. **Steel City**

c. **Appleton Electric**

2.4 WIREWAY

A. General

1. Provide wireway of the lay-in type and NEMA-rated for the area in which it is to be installed in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

2. Separate power, control, signal and communications cables by grounded metallic dividers in wireways or run in separate wireways.

B. Fittings and Covers

1. Provide fittings and sections with non-magnetic stainless steel screws.

2. Attach covers by hinges and clamps to the bodies.

3. Covers attached by means of clips or screws will not be accepted.

4. Provide covers and bodies constructed of aluminum or minimum 14-gauge steel.

C. Grounding

1. Ground the steel and aluminum wireway bodies.

2. Provide steel dividers with steel wireways or aluminum dividers with aluminum wireways, and ground by means of an individual grounding conductor.

3. Non-metallic dividers will not be accepted.

D. Terminations

1. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, or equal.

2. In other than outdoor areas, provide sealed locknuts and bushings.

PART 3 -- EXECUTION

3.1 GENERAL

A. Run wiring in raceway unless indicated otherwise.

B. Install raceways between equipment as indicated.

C. Provide raceway systems that are electrically and mechanically complete before conductors are installed.

D. Bends and Offsets

1. Provide bends and offsets that are smooth and symmetrical, and accomplished with tools designed for this purpose.

2. Provide factory elbows wherever possible.

E. Combined Raceways

1. Raceways other than those containing power conductors may be combined in strict accordance with the NEC and with prior written permission from the Engineer.

2. In general, combine only raceways containing the same type (control, signal, and the like) and voltage of conductors/cables, or dedicated conduits from one source to one device/equipment, in accordance with the NEC.

3. Permission from the Engineer shall not relieve the Contractor of responsibility to meet national, state and local requirements.

4. Do not combine wiring for redundant systems into single raceways.

F. Routing

1. Where raceway routings are indicated, follow those routings to the extent possible.

2. Where raceways are indicated but routing is not indicated, such as home runs or on conduit developments and schedules, raceway routing shall be the Contractor's choice and provided in strict accordance with the NEC as well as customary installation practice.

3. Provide the raceway encased, exposed, concealed, or under-floor as indicated, except conceal conduit in finished areas unless specifically indicated otherwise.

4. Adjust routings in order to avoid obstructions.

G. Coordination

1. Coordinate between trades prior to installing the raceways.

2. The lack of such coordination shall not be justification for extra compensation, and any costs for removal and re-installation to resolve conflicts shall be part of the Contract Price.

H. Install exposed raceways parallel or perpendicular to structural beams.

I. Expansion Fittings

1. Install expansion fittings with external bonding jumpers wherever exposed raceways cross building expansion joints.

2. Install expansion/deflection fittings where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur.

3. Encased Expansion Fittings

a. Install encased expansion fittings wherever encased conduits cross building expansion joints.

b. Deflection type fittings shall not be required for encased conduits crossing an expansion joint within a single structure.

4. Provide expansion and expansion/deflection fittings constructed of the same material as the raceway to which they are installed.

J. Install expansion fittings with bonding jumpers wherever raceways cross building expansion joints.

K. Install exposed raceways at least 1/2 inch from walls or ceilings except that at locations above finished grade where damp conditions do not prevail, install exposed raceways at least 1/4 inch from the face of walls or ceilings by the use of clamp backs or struts.

L. Wherever contact with concrete or dissimilar metals can produce galvanic corrosion of equipment, provide a means of suitable insulation in order to prevent such corrosion.

3.2 CONDUIT

A. Provide exposed conduit manufactured of rigid galvanized steel, except as follows and unless indicated otherwise:

1. In chemical areas, provide Schedule 80 PVC conduit.

2. For conduit containing only grounding system bonding conductors, provide Schedule 80 PVC conduit.

B. Power conduit encased in concrete shall be constructed of Schedule 40 PVC.

C. Analog control or instrumentation conduit shall be RGS.

D. Concrete Encasement

1. Where PVC or RGS conduit is stubbed up from a concrete encasement, provide a PVC-coated RGS elbow.

2. The conduit shall emerge from the concrete in a direction perpendicular to the surface whenever possible.

3. Do not encase conduit in the bottom floor slab below grade.

E. Size

1. Provide exposed conduit of 3/4-inch minimum trade size.

2. Provide encased conduit of one-inch minimum trade size.

F. Install supports at distances required by the NEC.

G. Concrete cover for conduit and fittings shall not be less than 1-1/2 inches for concrete exposed to earth or weather, or less than 3/4 inch for concrete not exposed to weather or in contact with the ground.

H. Penetrations

1. Provide conduit passing through walls or floors with plastic sleeves.

2. Perform core drilling in accordance with the requirements of Section 26 00 00 – Electrical Work, General.

3. Conduits passing through a slab, wall, or beam shall not significantly impair the strength of the construction.

I. Conduits embedded within a slab, wall, or beam (other than those merely passing through) shall meet the following requirements:

1. Conduits with their fittings embedded within a column shall not displace greater than 4 percent of the gross area of cross section;

2. Conduits shall not be larger in outside dimension than 1/3 the overall thickness of the slab, wall, or beam in which it is embedded; and,

3. Conduits shall not be spaced closer than 3 outside diameters on centers.

J. Place the conduit such that cutting, bending, or displacing reinforcement from its proper location will not be required.

K. Coat threads with a conductive lubricant before assembly.

L. Joints

1. Provide joints that are tight, thoroughly grounded, secure, and free of obstructions in the pipe.

2. Adequately ream the conduit in order to prevent damage to the wires and cables inside.

3. Use strap-wrenches and vises to install the conduit, in order to prevent wrench marks on the conduit.

4. Replace conduit with wrench marks.

5. Where installed in chemical or fuel containment areas, the conduit shall not have joints or fittings located below the top of the containment area to prevent entry of chemicals or fuel into the conduit system.

M. Slope

1. Wherever possible, slope the conduit runs to drain at one or both ends of the run.

2. Wherever conduit enters a substructure below grade, slope the conduit in order to drain water away from the structure.

3. Take extreme care in order to avoid pockets or depressions in the conduit.

N. Where conduits from duct banks enter building walls below grade, transition to PVC-coated RGS at least 12” outside the wall. Installation of PVC-coated rigid steel conduit though a core-drilled hole in an exterior wall below-grade shall utilize a sealing device as manufactured by **Link Seal**, or equal.

O. Connections

1. Make connections to lay-in-type grid lighting fixtures by using flexible metal conduit not exceeding 4 feet in length.

2. Make connections to motors and other equipment subject to vibration by using liquid-tight flexible conduit not exceeding 3 feet in length.

3. Provide equipment subject to vibration that is normally provided with wiring leads with a cast junction box for the make-up of connections.

P. Provide conduit seal fittings in hazardous classified locations, in strict accordance with the NEC.

Q. Provide conduit, fittings, and boxes required in hazardous classified areas that are suitably rated for the area, and provide in strict accordance with NEC requirements.

R. Duct sealant shall be foam duct sealant such as **Polywater FST or approved equal.** Provide duct sealant at the following locations:

1. Where required by NEC Article 300.7.

2. In areas where chlorine gas or fumes from sodium hypochlorite exist to prevent passage of gas through the raceway system.

S. Empty Conduits

1. Tag empty conduits at both ends to indicate the final destination.

2. Where it is not possible to tag the conduit, identify the destination by means of a durable marking on an adjacent surface.

3. Install a pull-cord in each empty conduit in floors, panels, manholes, equipment, and the like.

4. Install a removable plug on empty conduits that terminate below grade, in vaults, manholes, handholes, and junction or pullboxes.

T. Identification of Conduits

1. Identify conduits at ends and at pulling points.

2. Identification shall be the unique conduit number assigned in the Contract Documents.

3. Other than 120 VAC panelboard circuits, if a conduit has not been assigned a unique number in the Contract Documents, assign a unique number following the numbering scheme used in the Contract Documents.

4. Assign a unique number to 120 VAC panelboard circuits, similar to the cable numbering scheme used in the Contract Documents.

5. Provide conduit identification by a stamped or engraved non-corroding metal tag attached to the conduit bushing.

6. Provide an engraved phenolic nameplate in accordance with the requirements of Section 26 00 00 – Electrical Work, General, or a computer printed self-adhesive label attached to the equipment or enclosure inside which the conduit terminates.

7. Markings with a pen or paint will not be accepted.

U. Identification of Pullboxes and Junction Boxes

1. Identify pullboxes and junction boxes.

2. Identification shall be the unique conduit number assigned in the Contract Documents, or if not assigned a unique number the Contractor shall assign one following the numbering scheme used in the Contract Documents.

3. Provide box identification by a stamped or engraved non-corroding metal tag or an engraved phenolic nameplate, in accordance with the requirements of Section 26 00 00 – Electrical Work, General, and attached to the box or enclosure.

4. Markings with a pen or paint will not be accepted.

V. Provide conduit for data cables in accordance with the equipment manufacturer's recommendations, especially regarding separation from low- and medium-voltage power raceways.

END OF SECTION

SECTION 26 05 36 - WIRING DEVICES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide wiring devices, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 – Electrical Work, General apply to this Section.

C. Single Manufacturer

1. Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit complete catalog cuts of switches, receptacles, enclosures, covers and appurtenances, marked to clearly identify the proposed materials.

2. Submit documentation showing that the proposed materials comply with the requirements of NEC and U.L.

3. Submit documentation of the manufacturer's qualifications.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Devices shall carry the U.L. label, and shall be designed for use with stranded copper conductors.

B. Color

1. General purpose duplex receptacles and toggle switch handles shall be Brown everywhere except unless otherwise indicated.

2. Special purpose receptacles shall have a body color as indicated.

C. Receptacles and switches shall be of specification grade and shall conform to NEMA WD-1, Federal Specifications W-C-596E and W-S-896E, respectively.

2.2 LIGHTING SWITCHES

A. Toggle switches shall be AC only type switch.

1. 20A, 120/277V, Single, Double, 3-Way and 4-Way, Respectively

a. **Leviton**: 1221-2, 1222-2, 1223-2, 1224-2
b. **Hubbell:** HBL1221, HBL1222, HBL1223, HBL1224
c. **Pass and Seymour:** PS20AC1, PS20AC2, PS20AC3, PS20AC4
d. **Or Equal**

2.3 GENERAL PURPOSE RECEPTACLES

A. Duplex receptacles shall be of the polarized 3-wire type for use with a 3-wire cord with grounded lead, and one designated stud shall be permanently grounded to the conduit system in accordance with NEC article 406.4.

B. Dry Areas

1. NEMA Configuration #5-20R: duplex receptacle rated 125V, 20A

a. **Leviton:** #5362
b. **Hubbell:** #HBL5362
c. **Pass and Seymour:** #5362A
d. **Or Equal**

2. NEMA Configuration #5-30R single receptacle rated 125V, 30A

a. **Leviton:** #5371
b. **Hubbell:** #HBL9308
c. **Or Equal**

C. Damp/Wet Areas

1. Receptacles for damp/wet locations shall be weather-resistant with extra duty, in-use listed covers in accordance with NEC Article 406.8.

D. GFCIs

1. Ground-fault circuit-interrupting receptacles (GFCIs) shall be installed at the indicated locations and as required by the NEC.

2. GFCIs shall be duplex receptacles, of specification grade, and tripping at 5 mA.

3. GFCI ratings shall be 125V, 20 amperes, NEMA WD-1, Configuration 5-20R, and capable of interrupting 5,000 amperes without damage.

4. GFCIs shall be weather resistant-listed in accordance with NEC Article 406.8.

5. Feed-through-type GFCIs serving standard receptacles will not be permitted.

a. **Leviton:** G5362-WT
b. **Hubbel:** GFR5362SG
c. **Or Equal**

E. Hazardous Locations

1. Receptacles for hazardous locations shall be of the single-gang type with a spring door.

2. The receptacles shall be provided with a factory-sealed chamber.

3. The receptacles shall be provided with a delayed action feature requiring the plug to be inserted into the receptacle and rotated before the electrical connection is made.

4. The receptacle shall not work with non-hazardous rated plugs.

5. One plug shall be furnished with each receptacle.

6. The receptacles shall be rated for 20 amps at 125 VAC.

a. **Appleton:** EFSB
b. **Crouse-Hinds:** ENR
c. **Hubbell Killark:** UGR
d. **Or Equal**

7. Ground-Fault Protection: where indicated, hazardous location receptacles shall be provided with ground fault protection.

a. **Appleton** EFSR-GFI
b. **Crouse-Hinds** GFS-1
c. **Hubbell Killark:** UGRGF
d. **Or Equal**

2.4 ENCLOSURES AND COVERS

A. Surface-mounted switches and receptacles shall be housed in FS or FD-type weatherproof conduit fittings.

B. Switch and receptacle covers on surface-mounted boxes shall be constructed of die-cast copper-free aluminum.

1. **Appleton**: FSK
2. **Crouse-Hinds**: DS185 and WLRD-1
3. **Hubbell Killark**: FZ and FC
4. **Or Equal**

C. In finished areas, switch and receptacle covers shall be constructed of stainless steel.

D. Wet Locations

1. Receptacles in wet locations shall be provided with a hinged non-metallic Clear cover/enclosure marked "Suitable for Wet Locations when in use" and "UL Listed."

2. Provide a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base.

    a. **Appleton**: WCIU
    b. **Crouse-Hinds**: TP74
    c. **Hubbell TayMac:** Extra Duty
    d. Or Equal

2.5 NAMEPLATES

A. Provide nameplates or equivalent markings on the switch enclosures to indicate the ON and OFF positions of each switch.

B. ON and OFF for 3-way or 4-way switches will not be accepted.

C. Provide receptacles for special purposes with nameplates indicating their use.

D. Nameplates shall meet the requirements of Section 26 00 00 – Electrical Work, General.

PART 3 -- EXECUTION

3.1 GENERAL

A. Perform WORK in accordance with the requirements of the NEC.

3.2 CONNECTION

A. Rigidly attach wiring devices in accordance with the NEC and as indicated, avoiding interference with other equipment.

B. Securely fasten nameplates using screws, bolts, or rivets centered under or on the device, unless otherwise indicated.

C. Nameplates shall meet the requirements of Section 26 00 00 – Electrical Work, General, and shall consist of a red plate with white letters a minimum of 1/4 inch tall.

3.3 GROUNDING

A. Devices, including switches and receptacles, shall be grounded in accordance with NEC, Article 250, and Section 26 05 26 – Grounding.

B. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

C. Flush Receptacles

1. Flush receptacles and their metal plates shall be grounded through positive ground connections to the outlet box and grounding system.

2. Maintain the ground to each receptacle by a spring-loaded grounding contact to the mounting screw, or by a grounding jumper, each making a positive connection to the outlet box and grounding system at all times.

D. Receptacles served from an uninterruptible power supply shall be provided with an isolated grounding conductor from the serving power panelboard.

3.4 FIELD TESTING

A. Provide checkout, field, and functional testing of wiring devices in accordance with Section 26 00 00 – Electrical Work, General.

B. Test each receptacle for polarity and ground integrity, using a standard receptacle tester.

END OF SECTION

SECTION 26 05 43 - UNDERGROUND RACEWAY SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide underground raceway systems, complete and in place, as indicated in accordance with the Contract Documents.

B. Manholes, pullboxes, and fittings that are dedicated to the underground raceway system shall comply with the requirements of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures, and Section 26 00 00 – Electrical Work, General.

B. Shop Drawings

1. Submit complete catalog cuts of all raceways, fittings, pull boxes, and manholes, marked where applicable in order to show proposed materials and finishes.

C. As-Built Drawings

1. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

2. Show routings, burial depths, manhole and handhole locations and sizes, and where applicable, connections to drainage systems.

3. Furnish the drawings to the Engineer in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

PART 2 -- PRODUCTS

2.1 MANHOLES AND PULLBOXES

A. Frames and Covers

1. Provide traffic-type covers with an H-20 loading, except as otherwise indicated.

2. Identify manhole and pullbox covers as "ELECTRIC" by providing raised letters cast into the covers.

3. Provide frost-proof and water-tight grey iron frames and covers with solid lids and inner lids, and with 28-inch clear openings.

4. Bolt the covers and lids to cast-in-place steel frames using corrosion-resistant hardware.

5. Factory-prime the frames.

6. Provide covers constructed of cast-iron and provide pick holes.

7. Provide frames with a 1/2-inch drilled and tapped hole and lug in order to accommodate a No. 4/0 AWG bare stranded copper conductor connected to a ground rod and the ground conductor of power cables passing through the manhole.

B. Equip manholes and pullboxes with pulling-in irons, opposite and below each ductway entrance.

C. Provide manholes and pullboxes with closed bottoms; open-bottom manholes and pullboxes will not be accepted.

D. Brackets

1. Provide non-metallic, non-conductive brackets and stanchions in manholes as required for racking wiring through the manholes. Attach to manhole walls using stainless steel anchors and hardware.

2. Brackets and stanchions: **Underground Devices, Inc.,** or equal.

E. Precast Manholes and Pullboxes Manufacturer, or Equal

1. **Jensen Precast**

2. **Old Castle**

3. **Fogtite**

PART 3 -- EXECUTION

3.1 GENERAL

A. Install underground raceways between manholes and pullboxes as indicated.

B. Raceway systems shall be electrically and mechanically complete before conductors are installed.

C. Provide bends and offsets that are smooth and symmetrical, and fabricated with tools designed for this purpose.

D. Use factory elbows wherever possible.

E. To the extent possible, follow the raceway routings as indicated on the Drawings.

F. Adjust the indicated routings as necessary in order to avoid obstructions.

G. Coordination with Other Trades

1. Coordinate with other trades prior to installation of raceways.
2. The lack of coordination shall not be justification for extra compensation.
3. Perform removal and re-installation to resolve conflicts as part of the WORK.

END OF SECTION

SECTION 26 05 50 – ELECTRIC HEAT TRACING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide electric heat tracing systems, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

ISA-S 5.1 Instrumentation Symbols and Identification.

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Contractor shall coordinate installation of electric heat tracing with piping insulation per Section 43 07 00 – Process Piping and Equipment Insulation.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Show the location of thermostats and interphasing with electric power supply.

2. Manufacturer's Data: Complete manufacturer's data of the electric heating cables and the thermostats.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Heat tracing shall consist of spiral wrapping with electrical heating cables as recommended by manufacturer under insulation with fiber glass sections, sealed and weatherproofed per Section 43 07 00 – Process Piping and Equipment Installation. The heating cables shall be controlled from thermostats installed in representative locations and accessible for adjustment. The heat tracing systems shall be installed complete, including heating elements, power connections, end seals, and controlling thermostats in accordance with the manufacturer's printed installation instructions.

2.2 BASIC MATERIALS

A. Heating Cable: The electrical heat tracing system shall consist of a flat, flexible, low heat density, electrical heating strip of parallel construction, consisting of a continuous inner core of conductive material between 2 parallel copper bus strips. The electrical insulation of the heater strip shall be polyester rated for 140 degrees F temperature, and its width shall be a minimum of 1/2-inch. It shall be suitable for operation on 120 volts.

B. Thermostats: A thermostat with a range of 40 degrees to 120 degrees F shall be provided for each heated pipe. It shall be double-pole, single-throw, and be mounted in a

weatherproof NEMA Type 4 enclosure. The capillary bulb shall be mounted on the pipe under the insulation. Heating strips for pipes over 2-inches in size shall be rated at 8 watts per foot; for pipes 2-inches and smaller they shall be rated at 4 watts per foot. Thermostats shall be 120vac.

C. Manufacturers, or equal

1. **Briscoe Manufacturing Co.**
2. **Chromalox (Emerson Electric Co.)**
3. **Nelson Electric (A Unit of General Signal)**
4. **Raychem Corporation**
5. **Thermon Manufacturing Company**
6. For thermostats: **Honeywell, Chromalox**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. Pipes, valves, equipment and appurtenances shall be provided with heat tracing where indicated. Where not indicated, heat tracing shall be provided in all cases where items could be endangered by freezing.

2. The Contractor shall assemble and install equipment in strict accordance with the manufacturer's published instructions under the supervision of the manufacturer's representative. Installation shall be accomplished by competent craftsmen in a workmanlike manner. Heating strips shall be cut in the field and wrapped on the pipelines as required.

B. Contractor Coordination: The Contractor shall coordinate installation with the electrical WORK, to ascertain the correct location of electrical outlets.

C. Electrical Circuit: The Contractor shall provide heat tracing electric circuits in accordance with the National Electrical Code, NFPA 70, Article 427. Ground fault protection shall be provided for the heat tracing by a Class B GFCI circuit breaker with 30 mA trip. The GFCI circuit breaker may be installed in the panelboard feeding the circuit or in an enclosure by the heat traced equipment.

3.2 TESTING

A. The Contractor shall prepare the equipment for operational use in accordance with the manufacturer's printed instructions. Each system shall be tested for proper operation and the thermostats shall be set.

3.3 ACCEPTANCE

A. Final acceptance of the equipment is contingent on satisfactory appearance and operation.

END OF SECTION

SECTION 26 05 73 – PROTECTIVE DEVICE STUDIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall perform the indicated short circuit and protective device studies for the electrical power system in accordance with the Contract Documents.

B. The WORK of this Section shall include protection studies for motors with solid state overload and overcurrent protection devices.

C. It is the responsibility of the Contractor to obtain the information required from the electric utility and appropriate vendors.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 QUALIFICATIONS

A. Short circuit studies, protective device evaluation studies, arc-flash hazard analysis studies, and protective device coordination studies shall be performed by a company that has been regularly engaged in short circuit and protective device coordination services for a period of at least 10 years.

B. The indicated studies shall be signed by the professional electrical engineer, registered in the State of Washington, responsible for the studies.

C. The studies shall utilize computer programs with proven reliability and accuracy for performing 3-phase fault-duty calculations.

1.4 CONTRACTOR SUBMITTALS

A. The indicated studies shall be submitted in two (2) phases and approved by the Engineer prior to final approval of the distribution equipment Shop Drawings and release of equipment for manufacture.

1. Phase 1 Submittals shall include the 480V switchgear, switchboards, panelboards, all 480V equipment feeders and branch circuits, 480V step-down transformers and their downstream panelboards.

2. Phase 2 Submittals shall be an update of the Phase 1 submittals and shall include all equipment included in the water treatment plant as well as all other equipment installed in the final work package.

B. An initial short circuit study shall be submitted with each phase. Each study shall be reviewed before the Engineer will approve the Shop Drawings for 480-volt distribution equipment.

C. An initial protective device coordination study shall be submitted with each phase. Each study shall be submitted within 90 days after the approval of the initial short circuit study.

D. An arc-flash hazard analysis shall be submitted with each phase for the equipment included in that phase of the work.

E. The short circuit, arc-flash hazard analysis, and protective device coordination studies shall be updated prior to Project Substantial Completion; utilize characteristics of as-installed equipment and materials.

F. The adequacy of the equipment "withstand" and interruption ratings shall be approved by the Engineer.

1.5 MANUFACTURERS' SERVICES

A. The low-voltage switchgear manufacturer shall furnish the services of a qualified field engineer and necessary tools and equipment in order to test, calibrate, and adjust the protective relays and circuit breaker trip devices as recommended in the power system coordination study.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 GENERAL

A. The studies shall include development of single-line and impedance diagrams of the power system.

B. The diagrams shall identify components considered in the study and the ratings of power devices, including transformers, circuit breakers, relays, fuses, busses, and cables.

C. The resistances and reactances of cables shall be identified in the impedance diagram.

D. The studies shall contain written data from the electric utility company regarding maximum available short circuit current, voltage, and X/R ratio of the utility power system.

E. The studies shall include every protective device and feeder included within the WORK.

F. The first upstream overcurrent device outside the WORK shall be used as a fixed reference.

G. The studies shall include all portions of the electrical distribution system for normal and standby power sources down to and including the 480-volt distribution system.

3.2 SHORT CIRCUIT STUDY

A. The short circuit study shall be performed with the aid of a digital computer program, and shall be in accordance with the following Standards:

ANSI/IEEE 141	Recommended Practice for Electrical Power Distribution for Industrial Plants
ANSI/IEEE 242	Recommended Practice for Protection, and Coordination of Industrial, and Commercial Power Systems
ANSI/IEEE C 37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
ANSI/IEEE C 37.13	Low-Voltage AC Power Circuit Breakers Used in Enclosures

3.3 PROTECTIVE DEVICE EVALUATION STUDY

A. The protective device evaluation study shall be performed in order to determine the adequacy of circuit breakers, molded case switches, and fuses.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the attention of the Engineer.

C. Do not utilize series-rated circuit breakers to meet short circuit requirements for this project.

D. Devices shall be fully rated to withstand available fault currents.

3.4 PROTECTIVE DEVICE EVALUATION STUDY

A. The protective device coordination study shall be performed in order to develop the necessary calculations to select power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low-voltage breaker trip characteristics and settings.

B. Any problem areas or inadequacies in the equipment due to prospective short-circuit currents shall be promptly brought to the Engineer's attention.

3.5 TIME/CURRENT COORDINATION CURVES

A. As a minimum, the time/current coordination curves for the power distribution system shall include the following items plotted on 5-cycle log-log graph paper:

1. Time/current curves for each protective relay, circuit breaker, or fuse demonstrating graphically that the settings will provide protection and selectivity within industry standards.
2. Each curve shall be identified and tap and time dial settings shall be specified.
3. Provide individual curves for each feeder unless identical to others.
4. Selectivity.
    a. Time/current curves for each device shall be positioned to provide the maximum selectivity to minimize system disturbances during fault clearing.
    b. Where selectivity cannot be achieved, the Engineer shall be notified as to the cause.
    c. Recommendations shall be included for alternate methods that would improve selectivity.
5. Time/current curves and points for cable and equipment damage.
6. Circuit interrupting device operating and interrupting times.
7. Indicate maximum fault values on the graph.
8. Sketch of bus and breaker arrangement.
9. Magnetizing inrush points of transformers.
10. Thermal limits of dry-type and liquid-insulated transformers (ANSI damage curve).
11. Emergency power sources and downstream protective devices.
12. Every restriction of the ANSI and National Electrical Code shall be followed, and proper coordination intervals and separation of characteristics curves shall be maintained.

3.6 ARC FLASH STUDY

A. The arc flash study shall be performed with the aid of a digital computer program in order to determine the “Arc Flash Protection Boundary” and “Personal Protective Equipment” (PPE) levels for applicable electrical distribution equipment, stand-alone disconnects, starters, and VFDs in the power distribution system.

B. The arc flash study shall be performed in conjunction with short circuit calculations and protective device coordination.

C. The arc flash study shall be in accordance with the latest version of the following Standards:

1. NFPA 70E - Standard for Electrical Safety Requirements for Employee Workplaces
2. IEEE 1584 - IEEE guide for performing Arc Flash Hazard Calculations
3. OSHA (29 CFR PART 1910) - Occupational Safety and Health Standards for General Industry
4. ANSI Z535.4 - Product Safety Signs and Labels

D. The recommended values for the “Arc Flash Protection Boundary” and PPE levels, based on the arc flash study results, shall be tabulated in the study.

E. Labeling

1. The digital computer program shall provide the “Arc Flash Protection Boundary” and PPE values in a format that can be directly printed on to labels.
2. The Contractor shall provide these labels in accordance with Section 26 00 00 – Electrical Work, General.

3.7 FINAL SUMMARY REPORT

A. Summarize the results of the indicated power system studies in a final report.

B. The report shall include the following items:

1. Single-line diagram.
2. Impedance diagram.
3. Tabulation of all protective devices identified on the single line diagram.
4. Time/current coordination curves.
5. Specific recommendations, if any.
6. Test instrumentation, condition, and connections, as applicable, for each study.
7. Computerized fault current calculations.
8. Any suggested changes to the protection scheme or equipment selection that will result in improved system reliability and safety.
9. Recommendations to minimize the arc flash energy.

C. The report shall include information concerning the computer program used for the study, as well as a general discussion of the procedure, items, and data considered in the preparation of the study.

D. Submit the final report to the Engineer.

3.8 PROTECTIVE DEVICE TESTING, CALIBRATION, AND ADJUSTMENT

A. Test, calibrate, and adjust the protective relays and circuit breaker trip devices in accordance with the recommendations in the power system coordination study.

B. Calibrate the MCPs as in accordance with the recommendations in the power system study.

C. Adjustments shall be made prior to energizing any electrical equipment.

END OF SECTION

SECTION 26 12 16 – PANELBOARDS AND GENERAL-PURPOSE DRY TYPE TRANSFORMERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide panelboards and general-purpose dry-type transformers, complete and operable, in accordance with the Contract Documents.

B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 CONTRACTOR SUBMITTALS

A. General: Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures and Section 26 00 00 - Electrical Work, General.

B. Shop Drawings

1. Transformers
    a. Dimension drawings
    b. Technical certification sheets
    c. Drawing of conduit entry/exit locations
    d. Transformer ratings, including:
        1) Voltage
        2) Continuous current
        3) Basic impulse level for equipment over 600 volts
        4) KVA
    e. Descriptive bulletins
    f. Product sheets
2. Panelboards
    a. Breaker layout drawings with dimensions and nameplate designations
    b. Component list
    c. Drawings of conduit entry/exit locations
    d. Assembly ratings including:
        1) Short circuit rating
        2) Voltage

3) Continuous current

e. Cable terminal sizes

f. Descriptive bulletins

g. Product sheets

h. Installation information

i. Seismic certification and equipment anchorage details

PART 2 -- PRODUCTS

2.1 GENERAL

A. Transformers

1. The transformers shall be dry type, designed, manufactured, and tested in accordance with the latest applicable standards of ANSI and NEMA.

2. Transformers shall be UL-listed and bear the UL label.

B. Panelboards

1. Panelboards shall be dead front factory assembled. Panelboards shall comply with NEMA PB-1-Panelboards, as well as the provisions of UL 50 - Safety Enclosures for Electrical Equipment and UL 67 - Safety Panelboards. Panelboards used for service equipment shall be UL labeled for such use. Lighting panelboards shall be rated for 120/208 volt, 3 phase operation as indicated. Power panelboards shall be rated for 480 volts, 3 phase, 3 wire operation, unless indicated otherwise.

2. The manufacturer of the panelboard shall be the manufacturer of the major components within the assembly, including circuit breakers.

2.2 TRANSFORMERS

A. Energy Efficiency: Standard dry-type transformers shall meet the energy efficiency requirements of the Department of Energy Code of Federal Regulations (10 CFR PART 431), DOE 2016 Efficiency Levels.

B. Ratings

1. kVA and voltage ratings shall be as indicated.

2. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96 - Guide for Loading Dry Type Distribution and Power Transformers

3. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Up to 9 kVA	40 dB
10 to 50 kVA	45 dB

51 to 150 kVA	50 dB

C. Construction

1. Insulation Systems

a. Transformers shall be insulated as follows:

1) 2 kVA and smaller: 150 deg C insulation system based upon 80 deg C rise.

2) 3 to 15 kVA: 185 deg C insulation system based upon 115 deg C rise.

3) 15 kVA and larger: 220 deg C insulation system based upon 150 deg C rise.

b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 deg C maximum ambient.

c. Insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM D 635 - Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

2. Transformer windings shall be copper.

3. Transformers shall have four 2-1/2 percent taps, 2 above and 2 below 480 volts.

4. Transformer shall include vibration dampeners between the core and the enclosure to minimize and isolate sound transmission.

D. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal**.

2.3 PANELBOARDS

A. Ratings

1. Panelboards rated 240 VAC or less shall have short circuit ratings not less than as indicated by the Contract Drawings or Short Circuit Study, whichever is greater.

2. Panelboards rated 480 VAC shall have short circuit ratings not less than as indicated by the Contract Drawings or Protective Device Study, whichever is greater.

3. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

B. Construction

1. Lighting and power distribution panels shall have tin-plated copper bus bars.

2. Breakers shall be one, 2, or 3 pole as indicated, with ampere trip ratings as required by the equipment. Breakers shall be quick-make and quick-break, inverse time trip

characteristics, to trip free on overload or short circuit, and to indicate trip condition by the handle position.

3. The panels shall have hinged doors with combination catch and latch. The front panels shall be so arranged that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.

4. Panelboards shall be rated for the intended voltage.

5. Circuit breakers shall be interchangeable and capable of being operated in any position as well as being removable from the front of the panelboard without disturbing adjacent units. No plug-in circuit breakers will be acceptable.

6. Lighting and power distribution panels which are not part of a motor control center shall be constructed in accordance with Section 26 00 00 – Electrical Work, General. Panels shall have the necessary barriers, supports, and liberal wiring gutters. Trim screws shall be stainless steel. Panelboard parts of metal other than copper, aluminum, or stainless steel shall be cadmium plated.

7. Panelboards shall be UL listed except for special enclosures which are not available with UL listing.

8. Panelboards shall be suitable for use as service entrance where indicated.

C. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company, or equal.**

D. Surge Protection Devices (SPD)

1. Provide integral SPDs in all panelboards. SPDs shall conform to Section 26 43 00 – Surge Protection Devices(SPD).

2. SPD units shall be rated for the voltage and phase service of the panel at 120 kA per phase or as indicated on the Contract Drawings.

PART 3 -- EXECUTION

3.1 GENERAL

A. WORK of this Section shall be installed as indicated in Section 26 00 00 – Electrical Work, General.

END OF SECTION

SECTION 26 23 00 -- STANDBY POWER GENERATION SYSTEM SWITCHBOARD

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PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide standby electrical switchboard, complete and operable in accordance with the Contract Documents.

B. The requirements of Section 26 00 00 - Electrical Work, General, apply to the WORK of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ANSI/NFPA 70	National Electrical Code
NFPA 110	Standard for Emergency and Standby Power Systems
UL 489	Molded Case Circuit Breakers and Circuit Breaker Enclosures
UL 891	Standard for Dead Front Switchboards
NEMA PB 2	Deadfront Distribution Switchboards.
ANSI C37.90	Relays and Relay Systems Associated with Electric Power Apparatus (Surge Withstand Capacity Tests, SWC)
ANSI C57.13	Requirements for Instrument Transformers

B. All equipment in this section shall bear the appropriate label of Underwriters Laboratories. The manufacturer shall provide UL listing documentation prior to procurement.

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall conform to the requirements of Section 26 00 00 - Electrical Work, General and the additional requirements herein.

1. Include outline drawings showing all physical dimensions, weights, and mounting details of the completely assembled equipment.
2. Include schematic diagrams showing the switchboard components and interconnections. The diagrams shall show external connections all the instruments, relays, controllers, etc.

B. Parts List and Data Sheets

1. Complete bill of material with data sheets on major components (circuit breakers, relays, instrument transformers, meters, etc).
2. Time current curves for circuit breakers.
3. Nameplate and switch escutcheon plate schedule.
4. Test procedures for final shop testing of the switchboard assembly.

C. Operation and Maintenance Data: The CONTRACTOR shall submit 5 copies of the operation and maintenance manuals for the ENGINEER's review. The data sheets shall include the following:

1. Operating Procedures
   a. Normal and standby power operating instructions.
   b. Control, stopping, shutdown, and emergency instructions.
   c. Special operating instructions.
2. Maintenance Procedures
   a. Routine maintenance.
   b. Adjustment and checking.
3. Original manufacturer's parts list, illustrations, assembly drawings, and all diagrams for maintenance.

1.4 QUALITY ASSURANCE

A. General: Materials shall be tested and inspected in accordance with Section 26 00 00 - Electrical Work, General and Section 26 01 26 - Electrical Tests and the following requirements.

B. Factory Tests: Design test reports conducted on the switchboard assembly shall be submitted.

1.5 SPECIAL CORRECTION OF DEFECTS REQUIREMENT

A. The system correction of defects period shall be no less than 2 years after initial startup.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The switchboard shall be new and shall consist of outdoor NEMA Type 3R metal non-walk-in enclosures with rodent- and bird-proof construction, front only access, circuit breakers, buswork, automatic transfer switch (ATS), customer power metering equipment, feeder/branch circuit breakers, lighting transformer and panelboard. The utility metering and service entrance disconnects shall be located in a physically separate lineup from the ATS, customer metering, etc. to reduce PPE requirements during O&M activities.

B. There shall be a separate section for each engine-generator unit including metering, protective relays, automatic controls, and system controller interface for the unit.

C. There shall be a master control section for control of the engine-generator units and the transfer switches. This section shall include the totalizing metering, synchronizing metering, and the system controller.

D. Additional sections for main distribution circuit breakers shall be sized as indicated. Circuit breakers shall be the same type as the generator breakers.

E. Manufacturer shall be **Automatic Switch Company, Lloyds Control, Inc., Russel Electric, Zenith Controls, Inc.**, or equal.

2.2 ENCLOSURE

A. The switchboard shall be free standing, NEMA 3R metal non-walk-in enclosures with rodent- and bird-proof construction, front only access, metal enclosed type, consisting of front removable panels. Hinged panel sections shall access all of the sub-panel mounted control equipment. The downstream end section shall be designed to permit future additions without disturbing the initial installation. The switchboard shall be constructed of formed sections of smooth, rolled sheet steel, bolted together and reinforced where necessary with structural steel members. Doors and interior panels shall be constructed of 12 gauge minimum formed sheet steel. Hinges shall be the concealed type and shall allow the doors to swing through not less than 105 degrees from the closed position. Each door shall be furnished with a multi-point latch that can be locked. Provide locks for each door. All locks shall be keyed alike. Vents or louvers shall be provided where required for adequate ventilation. All vents shall be equipped with replaceable dust filters.

B. Steel channel anchoring sills shall be furnished with the switchboard. Provisions shall be made for top or bottom cable entry.

C. Steel work shall be thoroughly cleaned after welding is completed. The cleaning process shall be followed immediately with a rust-resistant prime coat. All surfaces of the enclosure shall be finished ANSI 45 or 61 light gray enamel.

2.3 COMPONENTS

A. Main Bus

1. Provide phase bus, ground bus, and neutral lug as shown on the Contract Drawings. Busse shall be copper. Bolted busses connections shall be tin-plated after fabrication to provide maximum conduction characteristics with minimum maintenance.

2. Bolts at all joints shall be high tensile strength, and connections shall utilize spring-type (Belleville) washers to maintain torque values with minimum maintenance.

B. Nameplates

1. Nameplates shall be provided for instruments, metering, control switches, pushbuttons, indicating lights, circuit breakers, etc. In the case of instruments, instrument switches, and control switches where the function is indicated on the dial plate or on the switch escutcheon plate, no nameplate is required except where there are two or more similar devices performing similar functions on the same panel. In that case, nameplates shall identify the circuits.

2. Nameplates shall be made of black and white laminated phenolic or similar material with black letters engraved through a white top layer. The lettering shall be of a size and design such that it will be legible from reasonable angles of observation.

3. Nameplates shall be mounted using an extruded holder secured with corrosion resistant self-tapping screws to prevent warping. The use of adhesive type mounting is not acceptable.

C. Fuses

1. Potential transformer primary and secondary circuits to meters and instruments and DC control circuits shall be fused with cartridge type fuses. Secondary circuits to

protective relays, voltage regulators, circuit breaker trip circuits, and equipment of similar importance shall have fuses with special delay curves.

2. Fuses shall be mounted in pullout type fuse holders so that the fused circuits may be easily isolated.

D. Wiring

1. General: The switchboard shall be completely wired, and wires for connections to remote equipment shall be brought to terminal blocks. A suitable wiring duct system shall be installed for routing all wires within and between switchboard sections. Exposed wiring shall be kept to a minimum. There shall be no splices in the wiring and all connections shall be made at terminal studs or terminal blocks. Interpanel terminal blocks shall be used for interconnecting the wiring between adjacent panels at shipping splits. Suitable provision shall be made for training and supporting incoming cables from the point of entrance to the termination on terminal blocks.

2. Wire shall be 600 V, UL type, SIS VW-1, stranded copper, single conductor switchboard wire. Wire shall be No. 16 AWG or larger. Shielded cable shall be used for low all level circuits where required, and shall be 18 AWG minimum.

3. Terminal Markings: The wires interconnecting the various devices shall be labeled at both ends with identification markers. Wire markers shall be heat-shrink sleeve type. Both wires and terminal points at the terminal blocks shall be identified.

E. Power Metering

1. Provide switchboard solid-state metering where indicated. They shall be plus or minus 0.2 percent accuracy. The meter shall include a door mounted display unit and Ethernet communications port. The meter shall display and communicate at a minimum the following parameters:

   a. Volts, each phase and average.

   b. Current, each phase and average.

   c. Real Power, each phase and average.

   d. Apparent Power, each phase and average.

   e. VAR, each phase and average.

   f. Power Factor.

   g. Frequency.

   h. Hamonics, voltage to the 35th.

   i. Harmonics, current to the 35$^{th.}$

2. Include CTs and PTs of ratios as indicated or as recommended by the MCC manufacturer.

3. The CT leads shall terminate on shorting type terminal blocks, and the shorting bar shall be grounded to the switchboard ground bus.

F. Control and Instrumentation

1. All control and instrument switches shall be of the rotary switchboard type with handles on the front and the operating contact mechanisms on the rear of the panels. Contacts on control and instrument switches shall be of phosphor bronze

and shall operate with a wiping action. The switches shall have a continuous rating of 30 amp at 600 VAC.

2. Each control and instrument switch shall be provided with an escutcheon plate clearly marked to show each operating position. The switch identifications shall be engraved on the escutcheon plates or on separate nameplates.

2.4 CIRCUIT BREAKERS

A. Power Switching Elements: Switchboard shall be equipped with 100% rated circuit breakers having a solid state tripping device with capacities indicated. Provisions shall be made to padlock each breaker when in the OPEN position to prevent unauthorized closing. Breakers shall be equipped with a position switches to indicate breaker open and closed positions. Provide a shunt trip device in each electrically-operated breaker and where required for system operation.

B. RMS Solid State Trip Units

1. Circuit breakers shall be provided with a microprocessor based self-contained trip unit. External power shall not be required for operation when the breaker is in the closed position. Control power required shall be obtained from current sensors mounted in the breaker.

2. Rating plugs shall be provided to match the ampere rating of the circuit breakers.

3. The trip unit shall provide the protective functions indicated below. LED trip indicators and adjustable set points shall be provided for each of the protective functions. Settings shall be provided on a rotary switch for each protection function. Adjustment parameters shall be as follows:

   a. Long delay

   b. Short delay

   c. Instantaneous pickup

   d. Ground fault pickup – where shown or required

   e. Energy reduction features - where shown or required

   f. I2t time current curve configurations shall be provided for the short delay and ground fault time delay settings

4. A status indicator, pushbutton, and a trip reset switch shall be provided on the trip unit display.

5. Provide ground fault protection for 800 amp and larger circuit breakers.

6. Provide arc flash reduction feature(s) for 1200 amp and larger circuit breakers.

2.5 AUTOMATIC TRANSFER SWITCH

A. The automatic transfer switch (ATS) shall be a double-throw type with a definite neutral position rated at 480 volts, and with the ampacity, number of poles, withstand close rating (WCR) shown on the single line diagram. The load terminals of the ATS shall be de-energized when the ATS is in the neutral position; the duration of the neutral position shall be adjustable from zero to 30 seconds. The ATS shall comply with requirements of ANSI/UL 1008 and ANSI/NEMA ICS-2. Withstand close rating shall be based on time duration and not on a specific upstream or downstream circuit breaker.

B. The ATS shall be manually operable but the manual operating mechanism shall be declutched when the electric operator becomes energized. Mechanical and electrical interlocks shall be provided to prevent simultaneous closure of the normal and emergency positions.

C. The ATS shall include integrated controls featuring solid state timing and sensing relays. The ATS controls will include a programmable exercise feature. Protective features and indicators shall include:

1. Three-phase, close-differential under/overvoltage and loss of phase protection on the Normal source; dropout and pick-up voltage and time delays shall be adjustable.
2. System Controller Interface: The system controller shall have status and alarm output or communications port for connection to the plant SCADA system.
3. Three-phase, under/overvoltage and loss of phase protection on the Standby source.
4. Engine run C-form (N.O.+N.C.) contact closure; contact closure shall be adjustable from zero to 120 seconds after failure of the Normal source is detected. The engine run contact shall remain closed for an adjustable period of zero to 5 minutes after the load has been transferred back to the normal source (cool down period).
5. Circuitry shall be provided to prevent transfer to the Emergency source until Emergency source voltage and frequency are within adjustable values.
6. Adjustable time delay of retransfer of up to 10 minutes after the voltage of the Normal source has attained the pick-up setting on all phases and of the correct phase rotation.
7. The ATS shall be equipped with indicators for the switch being in the Normal and Emergency positions, Normal and Emergency power available, and Fault. Two "dry" contacts shall be provided for the Emergency position and two "dry" contact for the Normal position. Dry contacts shall be provided for normal and emergency power available status and fault condition. The contacts shall be wired to labeled terminals.
8. The automatic transfer switch shall be equipped with a programmable retransfer inhibit feature and retransfer warning contact such as an “elevator module”.
9. Mode selector switch: TEST-OFF-AUTO; the AUTO position shall cause engine start-up, transfer, and retransfer of the load on failure and subsequent restoration of the Normal source. The TEST position shall simulate failure of the Normal source for however long the switch is in the Test position.
10. The ATS shall include operator viewable controls indicating the status of power sources, switch position, alarms and time delays.
11. The ATS shall be provided with any controls necessary for operation of the load bank.

2.6 ANCILLARY EQUIPMENT

A. Provide the following accessories for the switchboard:

1. 208/120vac 3 phase transformer as shown on the Contract Drawings.
2. 208/120vac 3 phase lighting panelboard as shown on the Contract Drawings.
3. 480/277vac 3 phase surge protective device.
4. 208/120vac 3 phase surge protective device.
5. Thermostatically controlled 120vac heater in each section. The heaters shall be powered from switchboards 208/120vac panelboard.

6. Three full sets of all fuses utilized.

PART 3 -- EXECUTION

3.1 WORKMANSHIP

A. WORK shall be thoroughly performed and completed in a manner consistent with the best modern practices followed in the manufacture of power and control switchboards. WORK shall be done be workers skilled in their various trades.

3.2 TESTING

A. General: The switchboard shall be completely assembled and adjusted at the factory and given the manufacturer's standard shop tests and other tests, including those indicated below.

B. Switchboard Wiring and Buswork: The switchboard panel shall be given point-to-point circuit continuity tests and shall be subjected to standard production tests in accordance with the requirements of ANSI C37.20. The dielectric tests shall be made between ungrounded circuits and ground. The control switches shall also be checked for proper contact operation. Solid state component devices shall be disconnected and isolated from the wiring and buswork during dielectric testing.

C. Markings: Device markings, nameplate markings, conductor identifications, terminal block identifications, and the scales of meters and instruments shall be checked.

D. Automatic Transfer Switch, Metering, etc.: ATS and metering shall be checked for proper operating sequence. Calibration of the metering shall be done by the switchboard manufacturer.

E. Instruments: Indicating and recording meters shall be checked for proper operation by injecting 3 phase current and voltage into the appropriate circuits.

F. Functional Test

1. The automatic transfer switch in conjunction with the engine generator units shall be functionally tested after installation to verify compliance with the Contract Documents.

2. Various loading conditions shall be accomplished with load banks or site load, in accordance with Section 26 32 13 - Standby Generator System to verify operation of the automatic sequencing function. Fault conditions shall also be simulated to verify proper operation of the automatic prefault, fault, and recording networks.

3. Testing of the manual start, stop, and synchronizing controls shall be accomplished.

3.3 OPERATION AND MAINTENANCE INFORMATION

A. General: Data shall be prepared in instructional form and in the format listed in Section 01 33 00 – Submittal Procedures.

B. Data Sheets

1. Standard catalog cuts, descriptive literature, parts sheets, illustrations, and other data shall be either original sheets provided by the manufacturer, or copies of equal durability and clarity. Data shall be clearly marked to identify pertinent information.

2. Data shall be supplemented with drawings to clearly illustrate the relations of component parts of equipment and systems.

C. Operational Descriptions: Data shall be supplemented by written text, and shall include the following:

1. Description of the system component parts including at least the following:

a. Switchboard

b. Power metering

c. Automatic transfer switch

2. Description of operating procedures including:

a. Start up, routine, and normal operating instructions

b. Control, stopping, and emergency instructions

c. Special operating instructions

D. Maintenance Procedures: Maintenance procedures shall include the following:

1. Routine maintenance

2. Alignment, adjusting, and checking

3.4 TRAINING AND ASSISTANCE

A. Furnish OWNER's personnel with a minimum of 1 Day orientation and training for the switchboard and system controls. This training shall be conducted by manufacturer’s representative personnel familiar with the installed system.

B. Furnish training and reference materials required for the training of up to 3 people.

C. Prior to factory testing, submit an outline of training topics and activities for OWNER's review.

3.5 INSTALLATION

A. Switchboard and associated equipment shall be installed by the CONTRACTOR in strict conformance to the manufacturer's instructions.

B. Manufacturer shall provide information to the CONTRACTOR for proper installation.

END OF SECTION

SECTION 26 32 13 - STANDBY POWER GENERATION

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide engine-driven standby electrical generating systems, complete and operable, in accordance with the Contract Documents.

B. The Contractor shall be responsible for coordination of interface with other equipment and for any special construction necessary to complete the WORK of this Section in an acceptable manner.

C. The supplier of the generator sets shall also be the manufacturer of the engine for the generator systems; however, the Contractor shall be responsible to the Owner for the WORK of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Materials shall conform with applicable requirements of the National Electrical Code (NEC), and any other State or Municipal codes which apply. Generator system shall meet applicable standards and codes, including IEEE, NEMA, ANSI, OSHA, and UL.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Detailed, dimensioned Shop Drawings and data demonstrating adherence to the requirements of these specifications shall be submitted and approved before fabrication, shipment, or other WORK under this Section begins. Include the manufacturer's certification that engine atmospheric emissions will comply with the limitations.

2. Certified custom drawings and custom wiring diagrams of each component in the system and a master wiring diagram showing the entire system on one sheet. This diagram shall include all AC and DC power control connections between the generator, engine, fuel tank system, batteries, and circuit breakers and shall be a custom drawing for this specific installation. A master drawing of the engine/generator set shall also be provided, showing general dimensions, bill of materials, location and size of all connections for fuel, cooling, exhaust, direct current connections, conduit locations, and connections for control and power wiring. Include wire and terminal numbers for all diagrams. Furnish kW output curves, fuel consumption curves, and certified air emission data sheets.

3. Outline drawings and connection diagrams shall be complete enough to enable the installation to be designed completely, and connection diagrams shall give both internal and external connections. Include foundation loading and clearances.

4. Five copies of complete and detailed instructions for the operation, lubrication, and maintenance of equipment in the system. The manuals shall be furnished after final approval of Shop and working drawings but prior to shipment of equipment. Manuals

shall be complete with wiring diagrams, lubrication schedules and recommended lubricants, drawings, cuts, parts lists, and other necessary data. All parts shall be numbered or otherwise clearly identified to facilitate ordering of replacements. Descriptions of all operational control devices and their functions shall also be included.

5. Anchoring: Provide information to allow calculation of the equipment anchors to meet the seismic requirements of the Site.

1.4 QUALITY ASSURANCE

A. The engine/generator shall be the product of a manufacturer who has been regularly engaged in the design and production of similar engine/generator sets for a minimum of 10 years.

B. The supplier shall maintain a local parts and 24-hour service facility within the 90 miles of the Site. The supplier shall have factory trained and authorized service representatives to furnish necessary installation, test, and start-up supervision as well as operation and maintenance training necessary for final approval and acceptance.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide a new diesel engine-powered electric generator set, in an outdoor weatherproof non-walk-in enclosure, sub-base fuel tank and load bank.

2.2 SYSTEM COMPONENTS

A. The engine generator shall have a minimum nominal standby rating as shown on the Contract Drawings power factor, 480 volts, three phase, four wire, 60 Hertz. The equipment package shall include in general, and as applicable, engine and generator on a common vibration isolating base, with auxiliaries, accessories, and controls, including intake filters, discharge silencer, turbocharger, heat exchangers, foundation bolts, isolators, piping, flexible couplings, supports, complete exhaust piping, ring, and silencer, insulation, control panels, lubrication system, engine and alternator heaters, cooling system, fuel tank, batteries and battery rack, battery charger, spare parts, and all materials necessary to permit installation, testing and placing the system in successful operation.

B. Provide two circuit breakers located in the generator enclosure for the output load and load bank connection.

C. Provide a load bank sized to meet the generator manufacturers maintenance and warranty requirements. Provide generator and load bank controls, interfaces, etc. as necessary for load bank operation. Coordinate load bank operation with automatic transfer switch controls.

D. Provide one 24 hour fuel storage tank with double wall construction, integral with the base of the generator-set and generator-set enclosure. Provide vibration isolation pads between the tank and concrete pad as recommended by the manufacturer.

E. The generator-set, enclosure, base-mounted fuel tank, and accessories shall be assembled and shipped to the Site as a complete, coordinated package, ready for installation. The engine generator base, cooling system, etc., shall be factory painted before installation in the enclosure.

2.3 SYSTEM OPERATION

A. The system shall operate as follows:

1. Automatic Control

a. A maintained remote contact closure from the automatic transfer controls in the plant switchboard shall cause the generator-sets to start and run.

b. When the remote startup contact opens, the engine shall continue to operate for an adjustable cool-down time (typically 5 to 30 minutes).

2. Local Control: The generator-set shall be capable of manual initiation or stopping from the locally mounted generator control panel. The local generator control panel shall be provided as part of this Contract.

3. Emergency Stop Control: An emergency stop pushbutton shall be provided at the generator control panel that shall cause the unit to stop without any delay.

2.4 ENGINE

A. The Contractor shall provide a complete engine-powered standby electrical generating system of the type and capacity indicated.

B. The diesel engine shall be mounted on a common base with the generator and the direct connected radiator and shall be rated for standby service, continuously for the duration of the electric power interruption, with engine jacket water cooled by means of a direct mounted water-to-air radiator under SAE conditions at 85 degrees F, 1500 feet above sea level. It should be noted that this is the rating of the engine.

C. The diesel engine shall be four-cycle, turbocharged (if used), aftercooled (if used), 1800 rpm maximum, with individual fuel pumps and injection valve for each cylinder. The generator-set shall be **Caterpillar, Cummins,** or equal.

D. The engine shall have a dry-type air cleaner with service indicator, fuel oil filter, full pressure positive pump lubrication with full-flow oil filters, thermostatic regulated oil cooling system, and crankcase drain with valving to be able to drain the crankcase oil without reaching under the engine.

E. The engine shall also be equipped with thermostatically controlled jacket water heater(s). Power shall be provided from a power source external to the engine generator enclosure.

F. The diesel engine shall perform as indicated when operating on a commercial grade of non-premium distilled petroleum fuel oil such as No. 2 domestic burner oil and diesel fuel.

G. The engine shall be equipped with an electric 24-volt dc starting system of sufficient capacity to crank at a speed which will start the engine under conditions indicated. Include a charging alternator. The starting pinion shall disengage automatically when the engine starts. The starting system shall include relays for fully automatic operation from a remote signal.

H. The engine shall be provided with a speed control and electronic governor.

2.5 BATTERIES AND BATTERY CHARGER

A. Provide battery(s) with sufficient capacity for three 30 second cranking cycles, allowing 10 seconds between cycles at minimum ambient temperature. Submit calculations verifying adequate capacity. The battery shall be on a non-metallic rack or case as close as

practical to the starter motor. The Contractor shall provide vented, nonmetallic protective covers or red and black plastic or rubber boots covering all terminals to protect against an accidental short circuit as might be caused by laying a metallic object on the battery. Metallic racks and covers are not acceptable.

B. A unit-mounted battery charger for 120 or 208 V, single phase, 60 Hz input shall be provided. The battery charger shall be voltage regulated, with separate float and equalize charge voltage adjustment having a 10 amp rating minimum. The battery charger shall include alarm relays to sense high and low dc voltage, zero current, and ac power failure, with individual output contacts wired to terminal strips for tie into remote alarms. Also, provide an ac “on” indicating pilot LED light and dc voltmeter and ammeter and annunciator.

C. Provide a thermostatically controlled 120 or 208 vac battery heater.

2.6 EXHAUST SYSTEM

A. The engine shall be provided with an exhaust system consisting of flexible connection, exhaust silencer, steel piping, fittings, stainless steel hardware and supports, brackets, and rain collar.

B. The flexible connection shall be of the stainless steel bellows type with flanged ends. Flexible elements shall be stainless steel suitable for exhaust temperatures recommended by the engine manufacturer. The flexible connection shall be suitable for vibration isolation and for relieving stress caused by thermal expansion.

C. The exhaust silencer shall be a critical grade.

D. Exhaust piping shall be pitched upward from the engine and be provided with sufficient drains to eliminate condensation and rainwater. Exhaust piping shall be welded steel pipe. Elbows shall be welding type, standard wall. Flanges shall be welding slip-on type, 125 pound, either forged or plate steel. Exhaust piping shall be supported independently of the silencer. The silencer and exhaust piping shall be insulated with a minimum of 2-1/2 inches of calcium silicate with a stainless steel jacket and shall be supported as required. The weight of the exhaust and silencer shall not be supported by the engine.

2.7 COOLING SYSTEM

A. The engine shall be equipped with a liquid cooling system having sufficient capacity to effectively cool the engine when delivering full rated horsepower at the conditions stated above. A radiator and engine-driven fan of a type and capacity recommended by the engine manufacturer shall be included.

B. The radiator shall be sized in accordance with the engine manufacturer’s recommendation for use with 50 percent aqueous ethylene glycol. Air flow shall be controlled by a power inlet damper and a gravity discharge damper, both provided as part of the non-walk-in outdoor enclosure. Design ambient air temperature shall be 100 degrees F at sea level.

C. The engine shall have an engine-driven, gear driven centrifugal type water circulating pump for circulating water through the cooling system.

2.8 GENERATOR

A. The generator shall be nominally rated as shown on the Contract Drawings at .8 PF, 480 V, 3 phase, 60 Hz, 4 wire wye and shall be a brushless design with solid state permanent magnet generator (PMG) exciter. Other excitation methods are not acceptable. The

voltage regulator shall be solid state, generator mounted. Provide radio-interference suppression meeting commercial standards.

B. If a line to neutral short circuit occurs, the generator shall be capable of supporting 300 percent rated current for 10 seconds without externally mounted devices.

C. Voltage Regulation Tolerance: Plus or minus 1 percent of any present value over the 3 phase load range. Instantaneous voltage dip or rise, when measured with an oscilloscope, shall not exceed 25 percent upon full load application or rejection, and shall return to preset value within 0.5 seconds.

D. Waveform: Deviation factor of output voltage shall not exceed 5 percent and the value of any individual harmonic shall not exceed 2 percent of the fundamental when operating with an unbalanced load.

E. Temperature Rise: Temperature rise of any component shall not exceed the rise permitted by NEMA standards. The voltage regulator shall be adjustable minus 25 percent to plus 10 percent.

F. Bearing: Double sealed ball bearing, lubricated for life.

G. Provide thermostatically controlled 120 or 208 vac generator heater(s).

2.9 LOCAL DISCONNECT CIRCUIT BREAKERS

A. Provide generator mounted, 100% rated, circuit breakers, 3 pole, for the output load and load bank connections. Breakers shall utilize an adjustable solid state trip unit. Breakers shall be UL Listed. Breakers shall be enclosed and isolated from vibrations induced by the generator set. Provide breaker auxiliary contacts for position indication to the plant SCADA system. Provide ground fault protection for 800 amp and larger circuit breakers. Provide arc flash reduction feature(s) for 1200 amp and larger circuit breakers.

2.10 VIBRATION ISOLATORS

A. The engine and generator shall be mounted on a common system base and shall be provided with vibration isolators of number and size as recommended by the engine supplier to support the engine, generator, radiator, and base. The isolation mountings shall consist of steel or cast iron top and bottom housings incorporating steel springs or "donut" style isolators, located between the genset and the base, and shall be provided with built-in leveling bolts and built-in resilient chocks to control isolation and withstand lateral forces in all directions.

2.11 LUBRICATION AND COOLING FLUIDS

A. The supplier shall furnish the engine fully charged with lubricating oil and grease as specified by the manufacturer for continuous service. The cooling system shall be furnished with a full charge of 50 percent ethylene glycol.

2.12 GENERATOR SYSTEM CONTROL PANEL

A. The engine shall be provided with an integrally mounted instrument and control panel, vibration isolated, NFPA 110 compliant, dead front construction and containing at least the following equipment:

Coolant status/alarm indicator(s)
Oil status/alarm indicator(s)
Manual selector switch marked for “auto,” “run” or “manual,” and “stop/reset.”
Automatic starting controls (3 wire start/stop)
Fuel status/alarm indicator(s)
Low dc voltage alarm to indicate loss of charge on battery
Electrical status and alarm contacts
Running Time Meter (Non-Resettable)
Emergency stop switch
Voltmeter, ammeter, frequency meter

B. The following functionality shall be integral to the control panel.

1. The control shall include a graphical display with text based alarm/event descriptions.
2. Audible horn for alarm and shutdown with horn silence switch
3. Remote start/stop control
4. Local run/off/auto control integral to system microprocessor
5. Cooldown timer
6. Speed adjust
7. Voltage adjust
8. Voltage regulator V/Hz slope - adjustable
9. Password protected system programming

C. Wiring

1. Signal wiring shall be segregated from power wiring and be arranged neatly to facilitate tracing of circuits.
2. Plastic wiring wraps shall be used to bundle wires, except within wiring ducts. The bundles shall be securely fastened to the steel structure at suitable intervals not exceeding 12-inches in length. No open space hanging of wires will be permitted. Flexible stranded copper wiring shall be used throughout. No solid conductor wire shall be permitted.
3. Terminal blocks shall be provided for interconnections between remote devices and local control panel wiring. The terminal blocks shall be factory assembled on a mounting channel, and the channel shall be bolted to the inside of the panel. The terminals shall have a continuous marking strip using the nomenclature on the schematic diagrams. No more than 2 wires shall be terminated at any one terminal. Wire terminals shall have sleeve wire markers properly marked to match the schematic diagrams.

D. Communication

1. Fiber optic port to transmit generator data to/from a plant PLC-based control system.

2.13 GENERATOR ENCLOSURE AND FUEL TANK

A. Generator Enclosure

1. A weatherproof non-walk-in type enclosure shall be provided to house the engine/generator and accessories. The following standards and codes shall be met at a minimum:

   a. NFPA 70 (National Electric Code)

   b. NFPA 30

   c. NFPA 37

   d. NFPA 110

   e. UL 142

   f. API 620

B. The enclosure shall be constructed for mounting on a concrete pad. The enclosure shall conform to the following design criteria and be constructed.

Rigidity wind test equal to	150 MPH
Roof load equal to	50 lbs. per sq. ft.
Floor load equal to	200 lbs. per sq. ft.
Rain test equal to	4-inches per hour
Enclosure certified to meet	BOCA base building and mechanical codes

C. Test data on similar construction by the manufacturer shall be available to the Engineer upon request.

D. Roof and walls shall be steel. Skin colors may be the manufacturer's standard or alternatives may be submitted to the Engineer for selection. Roof assembly shall be cambered to aid in rain runoff.

E. Lifting provisions shall be provided at the enclosure base, with capacity suitable for rigging the entire assembly.

F. Access doors shall have a skin material matching the enclosure. Doors shall be fully gasketed to form a weathertight perimeter seal and be pad-lockable. Hinges and lock mechanisms shall be stainless steel.

G. Bolts, nuts, and washers shall be stainless steel.

H. A bird screen shall be installed on exhaust outlet.

I. Fuel Tank

1. An integral UL listed sub-base tank with rupture basin shall be provided, with the following: The tank shall have venting and emergency venting per UL 12 and NFPA 30; lockable fill cap, low-level and high-level alarm contacts. Provide an analog fuel level gauge visual indicator with 4-20mA analog output. The rupture basin shall include a level switch with alarm contact to indicate tank rupture. The entire enclosure/fuel tank package shall be UL listed for use with a diesel engine generator system and shall meet the previously indicated codes and standards.

2.14 SPARE PARTS

A. Two years of the following spare parts shall be furnished:

1. Air filters
2. Oil filters
3. Fuel filters

PART 3 -- EXECUTION

3.1 START-UP ASSISTANCE AND TRAINING

A. The manufacturer's representative shall furnish on-Site start-up assistance and shall inspect the installation prior to start-up and submit a certificate to verify that equipment is installed in accordance with the manufacturer's requirements.

B. Upon completion of startup and after acceptance by the Owner, the Contractor shall completely fill the fuel tank.

C. In addition, the manufacturer's representative shall provide on-Site training for operation and maintenance of all equipment included in this Section.

D. The following times shall be included, as a minimum, for the above tasks. A Day is defined as 8 hours on-Site, exclusive of meals and travel. Each task shall be considered a separate trip to the site. Dates and times for the trips shall be coordinated with the Owner.

1. Inspection of the installation: 1 Day
2. Startup assistance: 1 Days
3. Operation and Maintenance Training: 1 Day

END OF SECTION

SECTION 26 43 00 - SURGE PROTECTION DEVICES (SPD)

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install surge protective devices (SPD).

B. SPDs furnished under this Section shall be ANSI/UL 1449 Type 2 integrating both surge suppression and high-frequency noise filtering suitable for use on low-voltage distribution systems.

C. The requirements of Section 26 00 00 – Electrical Work, General, apply to the WORK of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Standards:

1. ANSI/UL 1449, Fourth Edition, Safety Surge Protective Devices

2. IEEE C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits

3. IEEE C62.45, Recommended Practice on Surge Testing for Equipment Connect to Low-Voltage (1000V and Less) AC Power Circuits

4. UL 1283, Safety Electromagnetic Interference Filters

5. NFPA 70, National Electric Code

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 26 00 00 – Electrical Work, General.

B. Shop Drawings:

1. Electrical and mechanical drawings for each type of unit, showing electrical ratings, dimensions, mounting provisions, connection details, and layout diagrams.

C. Product Data:

1. Manufacturer’s technical information, including catalog information.

2. Manufacturer's technical specifications with assembly and component ratings.

D. Certifications: Certification that SPD devices comply with standards referenced in this Section.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have at least five (5) years' experience manufacturing and servicing products substantially similar to those required and shall be able to submit documentation of at least 5 installations in satisfactory operation for at least five (5) years each.

B. Component Supply and Compatibility:

1. Obtain all products included in this Section regardless of component manufacturer from a single SPD manufacturer.
2. SPD manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. Components shall be suitable for the specified service conditions and shall be integrated into overall assembly by SPD manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. SPD shall be modular, high-energy, parallel design with fast-acting transient voltage suppression using metal oxide varistors. Equipment shall provide noise attenuation with electromagnetic interference filter.

B. SPD shall be suitable for operation under the following environmental conditions:

1. Relative Humidity: Zero to 95%, non-condensing
2. Frequency: 47 to 63 Hz
3. Temperature: Zero to 149°F
4. SPD operating voltage shall be suitable for the associated SPD location(s).
5. SPD shall be suitable for internal and external mounting. SPD shall be factory-mounted and integrated into distribution equipment specified under the following Sections:
    a. Section 26 00 00 – Electrical Work, General
    b. Section 26 12 16 – Panelboards and General-Purpose Dry Type Transformers

C. SPD shall include a surge suppression path for each mode as required for the system configuration. . Protection modes shall include, to the extent applicable, the following:

1. Line-to-line
2. Line-to-neutral
3. Line-to-ground
4. Neutral-to-ground

D. SPD shall include electromagnetic interference/radio frequency interference (EMI/RFI) noise rejection filter with attenuation up to 30 dB from 10 kHz to 100 MHz.

E. SPDs and components in the operating path shall have maximum continuous operating voltage greater than 115% of nominal system operating voltage.

F. ANSI/UL 1449 minimum withstand rating shall be 20 kA per pole, and ANSI/UL 1449 voltage protection rating for SPD shall not exceed the following:

Modes	**208Y/120**	**480Y/277**
L-N,L-G, N-G	800	1200
L-L	1200	2000

G. SPD surge capacity based upon IEEE C62.41 location category shall, as a minimum, be the following or higher as shown in the Contract Documents:

Category	**Application**	**Per Phase**	**Per Mode**
C	Service entrance	240 kA	120 kA
B	High exposure locations (distribution equipment)	160 kA	80 kA
A	Branch locations	120 kA	60 kA

H. Provide SPD equipped with the following accessories:

1. LED indicators for monitoring device status.

2. Dry contacts, “form C”, for remote annunciation of unit status.

I. Source Quality Control: Perform manufacturer’s standard factory tests on equipment. Tests shall be in accordance with ANSI/UL 1449.

J. Manufacturers: **General Electric, Eaton, Schneider Electric/Square D Company**, or equal.

PART 3 -- EXECUTION

3.1 GENERAL

A. Install SPD in accordance with equipment manufacturer’s written recommendations and instructions and the Contract Documents.

B. Where an SPD cannot be installed integral with the equipment to which it is connected, conductor length between suppressor and connection point shall be as short and as straight as possible.

END OF SECTION

SECTION 26 50 00 - LIGHTING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide design of interior and exterior lighting system, controls, luminaires and accessories, complete and operable, in accordance with the to meet state and local Code requirements and Contract Documents.

B. Interior lights will be controlled to meet the requirements as listed on the Contract Drawings or required by Code. Provide lighting controller(s), occupancy sensors, daylight sensors, dimming light switches, etc. as needed.

C. All non-occupancy controlled lighting will be automatically turned on during power outages to provide the NFPA 101 lighting level for egress.

D. Outdoor lights will be controlled to be off during daylight. Outdoor lights over egress doors will be automatically turned on during power outages to provide the NFPA 101 lighting level for egress.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Codes

NFPA 70	National Electric Code: 2023 Edition
NEMA 250	Enclosures for Electrical Equipment (1,000 Volts Maximum)
International Building Code (IBC)	Earthquake Requirements
UL-924	Standard for Safety Emergency Lighting and Power Equipment

1.3 CONTRACTOR SUBMITTALS

A. Furnish the following product information in accordance with the requirements of Section 01 33 00 – Submittal Procedures and 26 00 00 – Electrical Work, General.

B. Furnish the following information:

1. Interior Luminaires
    a. Catalog data sheets and photos
    b. Luminaire finish and metal gauge
    c. Lens material, pattern, and thickness
        1) Candlepower distribution curves in 2 or more planes
    d. Candlepower chart, 0 to 90 degrees
    e. Lumen output chart
    f. Average maximum brightness data in foot-lamberts
    g. Coefficients of utilization for zonal cavity calculations

h. Mounting or suspension details

i. Heat exchange and air handling data

2. Exterior Luminaires

a. Catalog data sheets and photos

b. Luminaire finish and metal gauge

c. Lens material, pattern, and thickness

d. IES lighting classification and isolux diagram

e. Fastening details to wall or pole

f. Location, and method of fastening

g. For light poles: wind loading; complete dimensions; and finish

3. Lamps

a. Voltages

b. Colors

c. Approximate life (in hours)

d. Approximate initial lumens

e. Lumen maintenance curve

f. Lamp type and base

4. Photocells

a. Voltage and power consumption

b. Capacity

c. Contacts and time delay

d. Operating levels

e. Enclosure type and dimensions

f. Temperature range

5. Interior and exterior lighting design drawings, etc. as submitted to or approved by the permit reviewer / Authority Having Jurisdiction (AHJ).

PART 2 -- PRODUCTS

2.1 LUMINAIRES

A. General

1. Additional WORK requirements are indicated in the Contract Drawings.

B. Provide luminaires and mounting accessories compatible with the mounting locations.

C. All lamps shall be LED and similar to those indicated on the Contract Drawings.

D. Provide NEMA-rated enclosures in accordance with the area classifications in which they are installed.

E. Provide minimum 18 AWG wire leads.

F. Exterior Installations

1. Installations shall be UL-labeled as suitable for damp or wet locations as appropriate.
2. When factory-installed photocells and/or motion sensors are provided, the entire assembly shall be UL-labeled.

PART 3 -- EXECUTION

3.1 GENERAL

A. In office and commercial type rooms installation methods normal for those types of rooms are permitted.

B. In treatment, chemical, mechanical and electrical equipment rooms the more stringent methods listed in the Contract Documents apply. All unarmored conductors and cables shall be enclosed in raceways or wireways.

C. Lighting power and control conductors and raceways shall not be used by non-lighting loads.

3.2 LUMINAIRES

A. General

1. Install in accordance with the manufacturer's recommendations.
2. Provide necessary hangers, pendants, canopies, and other accessories.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to the building as required to safely mount the luminaire.
4. Install the luminaire plumb and level.
5. The mounting heights indicated for wall-mounted or pendant-mounted luminaires are from the bottom of the luminaire to finished floor or finished grade, whichever is applicable.
6. Install each luminaire outlet box with a galvanized stud.
7. Provide additional seismic restraints where needed.
8. In office and commercial type rooms installation methods normal for those types of rooms are permitted.
9. In treatment, chemical, mechanical and electrical equipment rooms the more stringent methods listed in the Contract Documents apply. All wires shall be enclosed in raceways or wireways.

B. Pendant Mounting

1. Provide swivel-type hangers and canopies to match the luminaires, unless otherwise indicated.
2. Provide supports on each fixture mounted in a continuous-row arrangement.
3. Provide twin-stem hangers on single luminaires.

C. Finished Areas

1. Install the luminaires symmetrically with tile pattern.
2. Locate with the centerline of tile or with centerline of the joint between adjacent tile runs.
3. Install recessed luminaires tight to the finished surface such that no spill light will show between the ceilings and the sealing rings.
4. When installing on combustible low-density cellulose fiberboard, provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use luminaires suitable for mounting on low-density ceilings.
5. Junction Boxes
    a. Flush and Recessed Luminaires: Locate a minimum of one foot from the luminaire.
    b. In concealed locations, install junction boxes to be accessible by the removal of the luminaire.
6. Wiring and Conduit
    a. Provide wiring of a suitable temperature rating as required by the luminaire.
    b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.

D. Unfinished Areas
1. Locate the luminaires to avoid conflicts with other building systems and blockage of the luminaire light output.
2. Luminaire Suspension
    a. Provide 3/8- inch minimum threaded steel hanger rods.
    b. Scissor-type hangers will not be accepted.
3. For attachments to steel beams, provide flanged beam clips and straight or angled hangers.

3.3 CLEAN-UP

A. Remove labels and other markings, except the UL listing mark.
B. Wipe the luminaires inside and out in order to remove construction dust.
C. Clean the luminaire plastic lenses with an antistatic cleaner only.
D. Touch up painted surfaces of the luminaires and the poles with matching paint provided by the manufacturer.
E. Replace defective lamps at the Date of Substantial Completion.

3.4 COMMISSIONING

A. Provide commissioning services, reports, documents, etc as required by the energy code adopted by the AHJ.

END OF SECTION

SECTION 27 05 43 – FIBER OPTIC CONDUITS ALONG PIPELINES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide a fiber optic conduit system, in accordance with the Contract Documents.

B. Fiber optic cable splicing will be performed by a separate contractor under a separate contract with the Owner. That separate contractor will monitor installation of the fiber optic conduit system.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 SHOP DRAWINGS AND SAMPLES

A. The following shall be submitted in compliance with Section 01 33 00 – Submittal Procedures:

1. Catalog Data: Data on conduit system, pull boxes, conduit fittings, conduit sealant, pull rope, identification tape, warning signs.

2. Detailed bill of materials.

3. Drawings indicating the locations of all pull boxes with station numbers.

4. Catalog data on all testing devices plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.

5. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pull boxes that are required, including station number and a written description of the location.

    a. Pull tension calculations

    b. Detailed description of pull operation methods for all conduit runs

    c. Tools and equipment to be used for cable installation and testing

    d. Physical location of equipment setup and type

    e. Exact location of splice points

    f. Safety and manual assist cable pulling operations

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Conduit: 4-inch diameter PVC conduit, stiffness of DB-60, in accordance with ASTM F 512-Smooth-Wall Poly(Vinyl Chloride)(PVC) Conduit and Fittings for Underground Installation.

B. Pull Boxes: Pull boxes shall be approximately 32-inches wide by 49-5/8 inches long by 36-inches deep, designed for H-20 traffic loading unless otherwise indicated. Covers shall be galvanized steel with the words "Fiber Optics" in raised letters on the upper surface. Covers shall have locking devices and form a watertight seal to prevent surface water from entering. Knockouts in the sidewalls shall permit underground conduit side entry and exit. Provide **George Ingraham, Vikamatic** or equal.

C. Conduit Sealant: **Semco** duct sealing compound or equal.

D. Identification Tape: A 6-inch wide magnetically detectable warning tape with orange protective polyethylene jacket resistant to alkalies, acids, and other destructive elements shall be installed above the conduit along the entire length of the conduit route. The polyethylene tape shall be continuously imprinted "CAUTION-FIBER OPTIC CABLE". The warning tape shall be **Teletrace by George Ingraham, Vikamatic,** or equal.

E. Pull Rope: Low friction, polyethylene jacketed, polypropylene rope with 1800 psi of tensile strength. Provide **Vikamatic Fiber Glide** or equal.

F. Fiber Optic Cable: The following Specifications are representative of the FOC, but due to variations between cable manufacturing runs and manufacturers, the OWNER anticipates that the properties of the FOC may vary by as much as 25 percent. The CONTRACTOR shall include in the Bid all costs associated with the installation of FOC.

1. Outdoor, buried cable rated
2. Tight buffered
3. Single mode suitable for FDDI
4. 8.3-microns core diameter
5. 125-microns cladding diameter
6. 500-microns coating diameter
7. 900-microns tight buffer diameter
8. 24 optical glass fibers encased in primary polymer buffer
9. Primary buffer encased in a secondary hard elastomeric polymer buffer
10. Weight of 60 kg/km
11. Minimum bend radius during installation shall be 20 times outside diameter
12. Minimum bend radius under long-term tensile load shall be 10 times outside diameter

13. Outer diameter 8.0-mm

14. Tensile pull strength rating of 600 lbs.

G. The FOC will be shipped on reels which have approximately 4,000 to 6,000-feet of cable without splice.

PART 3 -- EXECUTION

3.1 CONDUIT INSTALLATION

A. Conduits shall be installed on one side of the trench, at least 2-inches and not more than 12-inches from the trench wall, at a depth of 3- to 4-feet below grade along the entire pipeline route. The conduit shall not cross over the pipe.

B. Conduits shall clear concrete structures and vaults associated with the pipeline by a minimum of one-foot.

C. The conduit shall gradually and smoothly slope up to the elevation of the pull box entrance. Use of manufactured bends shall be limited to an absolute minimum. Factory bends, if required, shall be no more than 22-1/2 degrees.

D. Conduit sections shall be joined in accordance with the manufacturers' recommendations. Joints shall be watertight.

E. CONTRACTOR shall install a pull rope in the conduit.

F. Conduits entering pull boxes shall be capped or sealed watertight.

G. Bedding and backfill shall be sand backfill in accordance with Section 31 30 00 - Earthwork, placed at least 4-inches thick below and above the conduit, compacted to at least 90 percent maximum density.

H. Conduit shall be installed in the annular space between the carrier pipe and the casing or tunnel liner for all two-pass tunnel or jack and bore sections of the pipeline alignment.

3.2 PULL BOXES

A. Field Location of Pull Boxes

1. The Drawings diagrammatically indicate the desired location of pull boxes, conduit runs and other items. Exact locations shall be determined by the CONTRACTOR based on physical size and arrangement of equipment, finished elevations, calculated cable pulling tensions, field obstructions, and the criteria below. Indicated locations should be followed as closely as possible, however, pull boxes shall be located according to the following criteria:

   a. At no point shall the cable pulling tension exceed 600 pounds. If cable pulling tension is calculated to exceed 600 pounds, additional pull boxes shall be provided at no extra cost to the OWNER.

   b. The maximum distance between any two pull boxes shall not exceed 1,200 feet.

c. Within the 1,200-feet distance, the CONTRACTOR shall install pull boxes at locations wherever the cumulative change of direction of the conduit exceeds 180 degrees.

d. The minimum bending radius for conduit shall be 3-feet.

e. A pull box shall be installed on one side of a tunneled crossing. However, for any crossing which requires more than 180 degrees of conduit bends to account for elevation differences or route adjustments, a pull box shall be installed on both sides of the crossing.

B. Construction

1. The CONTRACTOR shall install the pull box covers so that the top of the cover is flush with the restored pavement. Pull boxes installed in soil areas shall be installed so that the top of the cover is at least one-inch but not more than 4-inches above the final grade level of the restored surface to prevent accumulation of dirt, silt and debris on the top of the hand hole cover.

2. CONTRACTOR shall perform conduit integrity tests for each section between the pull boxes after backfilling and compaction using the test and procedures described in this Section. These tests shall be performed prior to installation of the pull rope.

3. Pull box conduit entries shall be sealed with mortar to prevent the intrusion of water and debris into the pull boxes.

4. Pull boxes shall be installed on a compacted level foundation consisting of 4-inches of granular material complying with Section 31 30 00 - Earthwork.

5. Backfilling around pull boxes shall not be done until mortar sealant has thoroughly set.

6. Compaction around pull boxes and associated details shall be performed in accordance with Section 31 30 00 - Earthwork.

7. Upon final acceptance of the conduit system, pull boxes shall be free of debris and water and be ready for cable installation.

3.3 MODIFICATIONS

A. All dimensions and exact locations of underground substructures shall be field verified. Minor changes in locations of pull boxes which result in no additional costs for material or labor shall be made as a part of the WORK. However, the CONTRACTOR shall prepare proposals consisting of detailed material lists, cost estimates, and schedules for rerouting the conduit around existing unforeseen underground utilities and structures which result in additional cost. The ENGINEER will consider the proposals in accordance with the change provisions of the General Conditions.

B. The CONTRACTOR shall consider the following when preparing proposals.

1. Manufactured bends shall be minimized

2. Required bends shall be less than 22-1/2 degrees

3. Clearances between conduits and other structures shall be:

Structures	Minimum Separations
Power or other foreign conduit	12 inches
Pipes for gas, oil, water, sewage	6 inches when crossing: 12 inches when parallel

3.4 CABLE MARKER SIGNS

A. The CONTRACTOR shall install marker signs for fiber optic cable on all marker posts for the pipeline as indicated.

3.5 CONDUIT SYSTEM CLEANING AND TESTING

A. Following the backfill placement and compaction, all conduits shall be cleared of loose material by brush and compressed air.

B. A test mandrel 3/8-inch smaller than the inside diameter shall be passed through all conduits to detect alignment and deformation problems. Mandrel shall be passed in both directions.

C. Cleaning and testing of the conduit shall be performed by the CONTRACTOR and witnessed by the ENGINEER. The cleaning and testing operation shall be conducted for each conduit section between adjacent pull boxes, a section at a time, for the entire route. The results of tests shall be documented by the CONTRACTOR and signed by the ENGINEER and the CONTRACTOR.

D. The CONTRACTOR shall provide a 5 Day advance notice of the schedule and location of test to the ENGINEER.

E. The CONTRACTOR shall remove and replace noncompliant conduit and shall repeat the test.

3.6 FIBER OPTIC CABLE INSTALLATION REQUIREMENTS

A. FOC shall be installed in continuous lengths without intermediate splices. The cable installation personnel shall be experienced with specific knowledge of the cable manufacturer's recommended procedures, and as a minimum WORK shall conform to the following:

1. The FOC's strength elements shall be properly attached to a 600 lb breakaway swivel using Kellums pulling grips.

2. Cable tensile limits and tension monitoring devices shall not exceed cable pull tension and bend limits.

3. Conduits shall be constantly lubricated during the pulling procedures.

4. Each pull box shall contain extra FOC for pull box slack.

B. The CONTRACTOR shall conform with the cable manufacturer's specifications, practices, and the following requirements:

1. When power equipment is used to install fiber optic cables, low speeds shall be used so that a rate of 30 meters per minute is not exceeded. The tensile and bending limitation for fiber optic cables shall not be exceeded under any circumstances. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the minimum bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load-cell instruments.

2. Conduit shall be cleaned and tested prior to installation.

3. Conduits shall have a lubricant applied at each conduit ingress and egress location and during the pull operation. Lubricant shall be **Polywater Type 5**, or equal.

4. FOC shall be installed using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions. Equipment shall be designed to prevent a preset pulling tension from being exceeded. The pulling tension setpoint shall be determined by the FOC manufacturer. If during the pulling operation excessive tension is detected, all operations shall cease, and the ENGINEER shall be notified.

5. Each pull shall be documented by a graph which is annotated with the following information:

    a. Reel number

    b. Date and time

    c. Sign-off by CONTRACTOR and ENGINEER

6. Under no conditions shall the FOC be left exposed or unattended.

C. FOC splicing shall be performed by others.

D. After the cables are installed and spliced, they shall be racked and spare conduits sealed. A minimum of 30-feet of FOC shall be stored at each end of one splice. Racking shall conform to the following:

1. Cables shall be loosely secured in racked position with **Ty-Raps** or equal.

2. Imprinted plastic coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each handhole. Tags shall be by **Brady** or **Thomas & Betts.**

3. All coiled cable shall be suitably protected to prevent damage to the cable and fibers. Racking shall include securing cables to brackets and racking hardware that extend from the sidewalls of the handhole.

4. When all cables at each handhole are securely racked, unused conduits and void areas around conduit containing cables shall be sealed using the **Semco** or equal material.

3.7 FOC TESTING

A. General: The CONTRACTOR shall perform pre-installation and post-installation FOC tests. The ENGINEER shall be notified a minimum of 10 Days in advance so that these tests are witnessed. Test equipment shall be traceable to NIST standards.

B. Test equipment: The CONTRACTOR shall use the following to perform the pre-installation and post-installation FOC tests.

1. Optical time domain reflectometer (OTDR). The OTDR shall be laser precision, **ALT, Inc. Model 5200 LRFL,** or equal.

C. Pre-installation tests

1. The purpose of these tests is to verify that the cable conforms to the manufacturer's specifications and is free of defects, breaks and damages by transportation and manufacturing processes. The tests shall certify continuity and attenuation or loss for each fiber on each reel and document results of physical inspections to identify any cable and reel damage conditions, and any deviations from the manufacturer's specifications.

2. The CONTRACTOR shall perform tests on all reels of cable. The ENGINEER shall be notified a minimum of 15 Days prior to any test.

3. The CONTRACTOR shall document each test and submit the report to the ENGINEER for review. Documentation shall consist of both hard copy and 3-1/2 inch electronic disk complete with all application software.

D. Post-installation tests: After FOC has been installed but prior to splicing, the following tests shall be performed:

1. Perform Tier 1 testing, test optical fiber cable using an optical loss test set (OLTS) to determine the continuity of the strand end to end.

2. Perform Tier 2 testing, a recording optical time domain refractometer (OTDR) shall be utilized to test end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1300 nm and 1550 nm light source for the single mode fiber (SMF). The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30-feet or more to display the required cable section.

3. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

4. A transmission test shall be performed with the use of a 1300 and 1550 nm stabilized light sources and 1300 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.

5. Hard and electronic copy of test documentation shall be submitted. The CONTRACTOR shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one db occurs, the ENGINEER shall be notified in writing by the CONTRACTOR, and the cable shall be removed and replaced.

6. Upon completion of the previous tests and all splicing operations, all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

END OF SECTION

27 15 26 - OUTDOOR FIBER OPTIC CABLING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide the fiber optic cable system, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.1 ANSI C8.47 Polyolefin-Insulated Thermoplastic Jacketed Communication Cables

EIA - 359	Standard Colors for Color Identification and Coding
EIA - 455(Addendum 1 through 5)	Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices
EIA - 455-27A	Method of Measuring (Uncoated) Diameter of Optical Waveguide Fibers
EIA - 455-28A	Method For Measuring Tensile Failure Point of Optical Waveguide Fibers
EIA - 455-34	Interconnection Device Insertion Loss Test
EIA - 455-89	Fiber Optic Cable Jacket Elongation and Tensile Strength
MIL - 202	Test Methods for Electronic and Electrical Component Parts
MIL - 454	Standard General Requirements for Electronic Equipment
MIL - 810	Environmental Test Methods and Engineering Guidelines
NEMA TC - 2	Conduit
NEMA TC - 3	Accessories
UL Standard 514	Accessories
UL Standard 651	Conduit

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Catalog Data: Catalog data on conduit system, pullboxes, conduit fittings, conduit plugs, pull rope, identification tape, and warning signs.

2. Detailed bill of materials.

3. Drawings indicating the locations of all pullboxes with station numbers.

4. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the National Institute for Standards and Testing.

5. Cable pulling calculations for all conduit runs. Indicate on the submittal any additional pullboxes that are required, including station number and a written description of the location.

6. A cable pulling and splicing work plan shall be submitted a minimum of 45 Days prior to the planned initiation of cable pulling. The pulling plan and pull tension calculations may be prepared by using a software program such as **Pull-Planner 2000** by **American Polywater Corporation**, or equal. The cable pulling and splicing work plan must be approved a minimum of 15 Days prior to pulling cable. Work plan shall include the following:

   a. Pull tension calculations

   b. Calculated amount of lubrication required

   c. Detailed description of pull operation methods for all conduit runs

   d. Tools and equipment to be used for cable installation and testing

   e. Physical location of equipment setup and type

   f. Exact location of splice points

   g. Safety and manual assist cable pulling operations

   h. Detailed schedule for pulling and testing cables

7. Information on at least one successfully performing fiber optic cable installation of comparable size and complexity installed in the recent past with name, address, and telephone number of facility owner, name of project and completion date, and type of conduit system and length of cable pulled.

8. The name and qualifications of the supervisory personnel that will be directly responsible for the installation of the conduit system.

C. Quality Assurance Submittals:

1. Test Report showing compliance with this Section

2. Manufacturer certification that cable is suitable for installation in conduit underground.

1.4 QUALITY ASSURANCE

A. The cable manufacturer shall be registered at ISO 9001.

B. The CONTRACTOR shall submit laboratory test reports on representative samples of similar cable design to demonstrate compliance with the following requirements prior to cable installation:

1. Tensile strength per EIA-RS-455-33A and EIA-RS-455-28A

2. Jacket shrinkage per EIA-RS-455-86

3. Cable twist per EIA-RS-455-85

4. Environmental temperature cycling per EIA-RS-455-3A

5. Flexing per EIA-RS-455-104

6. Impact resistance per EIA-RS-455-25A

7. Compressive strength per EIA-RS-455-41

8. Freezing test per EIA-RS-455-98A

9. Mechanical bend test per EIA-RS-455-37

1.5 WARRANTY

A. The CONTRACTOR shall furnish an unconditional warranty on cable for a minimum period of 2 years.

PART 2 -- PRODUCTS

2.1 MATERIALS

A. Conduit: Conduit shall be 3- or 4-inch diameter Schedule 80 PVC electrical conduit as indicated. Fittings shall be appropriate for underground installation

B. Cabinets: Cabinets shall be standard CALTRANS Type 332, furnished without traffic control components. Cabinet material shall be 0.125-inch aluminum, with full front and back doors, shall have stainless steel handles with padlock feature. Finish shall be natural aluminum. Cabinets shall accommodate 19-inch standard EIA rack assemblies. Cabinets shall be installed on reinforced concrete pads.

C. Pullboxes: Pullboxes shall be CALTRANS Standard No. 6, approximately 32-inches wide by 49-inches long by 36-inches deep, designed for H-20 traffic loading unless otherwise indicated. Covers for pullboxes in paved areas shall be galvanized steel, rated for H-20 traffic loading. Covers for pullboxes in sidewalks and unpaved areas shall be concrete. Bolts shall be 316 stainless steel. Covers shall have the words in raised letters on the top. Covers shall have locking devices and form a watertight seal to prevent surface water from entering. Knockouts in the sidewalls shall permit underground conduit side entry and exit.

D. Conduit Duct Plugs: **Jackmoon Simplex Duct Plugs** or equal, with bushing sleeves.

E. Pull Rope: Low friction, polyethylene jacketed polypropylene rope with 1800 psi tensile strength, **Vikamatic Fiber Glide,** or equal.

F. Fiber Optic Cable:

1. Cable Type: All dielectric outdoor plant stranded loose-tube, gel-filled fiber optic cable, **Corning Altos 012RW4-14101A20** or **Lucent Lightpack 7D1X-012-BXD**.

2. Number of fibers: 12 fibers.

3. Buffer Tubes

   a. Optical fibers shall be grouped inside a loose buffer tube. Tubes shall be color coded and arranged symmetrically around the central member.

   b. The fibers shall not adhere to the inside walls of the loose buffer tube. Buffer tubes shall be kink resistant within the specified minimum bend radius.

   c. Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogenous gel. The gel shall be free from dirt and foreign matter. The gel shall be readily removable with conventional nontoxic solvents.

   d. Buffer tubes shall be stranded around a central member using the reverse oscillation, or "S-Z", stranding process.

   e. Binders shall be applied with sufficient tension to secure the buffer tubes to the member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.

4. Each fiber shall be numbered and color-coded. The colors of the individual fibers shall be stable across the indicated storage and operating temperature range and not be subject to fading or smearing onto each other or into the gel filling material. Colors shall not cause fibers to stick together.

5. Cable Core

   a. Filler may be included in the cable core composition to lend symmetry to the cable cross section where needed.

   b. A central anti-buckling member shall be included in the cable. The anti-buckling member shall be composed of a glass reinforced plastic rod.

   c. The cable core shall contain a water-blocking material. The water blocking material shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter and shall be readily removable with conventional nontoxic solvents.

   d. Tensile strength shall be provided by a combination of high tensile strength dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.

6. The all dielectric cable shall be sheathed with medium density polyethylene (MDPE). The minimum nominal jacket thickness shall be 1.4-mm. Jacketing material shall be applied directly over the tensile strength members and water blocking material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metallic elements and shall be of a consistent thickness.

7. The cable shall contain at least one ripcord under the sheath for easy sheath removal.

G. Fan-Out Termination for Loose Tube Cables

1. Individual fibers within the loose tube cable require handling protection inside the termination cabinets. Fan-out kits shall be installed in the patch panel enclosures to transition the loose tube fibers to ruggedized tight-buffered fiber pigtail cables. Fan-out tubes or furcation kits shall not be used. Optical fusion splices shall connect the loose tube fibers to the tight-buffered pigtail cables. The optical splice loss shall comply with the specifications for optical splices. Splice protection sleeves shall protect all splices. A wall-mountable splice center shall house the splices and serve to fully protect excess lengths of loose tube fibers from exposure.

2. The tight-buffered pigtails shall be terminated with **ST** connectors.

H. Fan-Out Pigtail Cable Specifications: Single mode fiber (**Corning SMF-28,** or equal) shall be used in the pigtails. Optical characteristics shall comply with the optical fiber performance specifications.

Buffer material	Thermoplastic
Buffer OD	900 um
Strength Member	Kevlar
Jacket Material	PVC
Jacket OD	3.0-mm
Temperature Range	-20 to + 70 degrees C

I. Fiber Optic Termination Patch Panels

1. Where indicated, the fiber optic cable shall terminate inside a communications cabinet on a termination patch panel. Fiber sub-cables within the cable shall be terminated with STEM compatible connectors. The patch panel shall have a fiber capacity equal to the total number of fibers (connected and spare) for all cables to be connected. Patch panels shall be designed for either mounting on a standard equipment rack or housed in an enclosure for direct wall mounting. The patch panel shall contain STEM type bayonet couplings. Unused couplings shall have protective dust covers. Panels shall be furnished with locking doors. Factory-terminated, tight-buffered, aramid-reinforced fiber optic jumper assemblies or interconnect cables, standard 3.0-mm OD, shall connect the optical cable terminations to the patch panel couplings.

2. The termination patch panel shall be equipped with a suitable means for routing and securing of cables and shall provide a suitable means of protection for the mounted fiber connectors, to prevent damage to fibers and connectors during all regular operation and maintenance functions. Cables shall be provided with strain relief. Bend diameters on cable fibers and jumpers shall be greater than 4-inches for optical and mechanical integrity of the optical fibers.

3. Panels shall be equal to the following manufactured by **Secure**:

Mounting	Fiber Capacity	Model Number
Rack	48	**C.H.-02U**
Rack	72	**C.H.-03U**
Wall	48	**AC-048L** with lock
Wall	72	**AC-072L** with lock

J. Optical Connectors

1. Connectors shall be field-installable and perfectly matched to the cable used. The connectors shall provide tight fitting termination to the cladding and buffer coating. Epoxy-based or hot melt adhesives shall be used to bond the fiber and buffer to the connector ferrule and body prior to polishing the end face. No dry-termination or quick crimp connectors are allowed.

2. After termination with connectors, the fiber ends shall be visually inspected at a magnification of not less than 100 power to check for cracks or pits in the end face of the fiber. If irregularities cannot be removed by further polishing, the entire process shall be redone by cutting off and disposing of the connector body.

3. Connectors shall have a maximum allowable connection loss of 0.3 dB per mated pair, as measured per EIA-455-34. No index-matching gel is to be used; only dry interfaces will be accepted. Single mode connectors shall be capable of field installation of nine 125-micron fibers with 900-micron buffers (OD).

4. Each connector shall be of the industry standard **ST** type compatible, designed for single mode tolerances, and shall meet or exceed the applicable provisions of EIA-455-5, 455-2A, and 455-34, and shall be capable of 100 repeated matings with a maximum loss increase of 0.1 dB. Connectors shall incorporate a keyway design and shall have a zirconia ceramic ferrule. Connector bodies and couplings shall be made of corrosion-resistant and oxidation-resistant materials, such as nickel plated zinc, designed to operate in humid environments without degradation of surface finishes.

K. Splice Closures

1. Splice closures shall be of the re-enterable type, with an external moisture-proof shell, inner closure, and encapsulant.

2. Closure shall have removable interior splice trays.

3. Closures shall be **Corning Cable Systems (Secure) type SCN** or equal.

2.2 TRENCH BACKFILL MATERIALS

A. Slurry backfill for the installation of conduits that will contain fiber optic cable shall be a medium to dark red or orange color to clearly distinguish the backfill from other concrete and soil. The concrete shall be pigmented by the addition of commercial quality cement pigment to the concrete mix. The red or orange concrete pigment shall be **LM Scofield Company, Orange Chromix Colorant, Davis Colors**, or equal.

B. For trenches in pavement areas, only the top 4-inches of backfill will be required to be pigmented concrete. At the option of CONTRACTOR, the full depth may have the pigment.

PART 3 -- EXECUTION

3.1 CONDUIT INSTALLATION

A. General

1. Conduit sections shall be joined in accordance with the manufacturers' recommendations. Joints shall be watertight.

2. Conduit shall be cleaned and tested prior to installation of cables.

3. CONTRACTOR shall install pull rope in the conduit.

4. Conduits entering pullboxes shall be sealed with **Jackmoon Simplex** duct plugs.

5. The conduit shall gradually and smoothly slope up to the elevation of the pullbox entrance. Use of manufactured bends shall be limited to an absolute minimum. Factory bends, if required, shall be no more than 222 degrees.

6. Conduit trenching and backfill shall comply with San Diego Regional Standard Drawing G-33, Type A, with the following substituted for Note 10: "Select material with a sand equivalent of 50 minimum shall be backfilled to 3-inches minimum above the conduit. Sand cement slurry backfill may not be substituted for select material."

7. A trace wire shall be installed along the entire fiber optic cable route for use in active cable location. The trace wire shall be a #8 AWG bare-copper solid strand. No insulation or other coating material shall be on the trace wire. The trace wire shall have a termination at each pullbox for connection to testing equipment.

8. Identification Tape: A 6-inch wide magnetically detectable warning tape with orange protective polyethylene jacket resistant to alkalies, acids, and other destructive elements shall be installed along the entire length of the conduit route. The polyethylene tape shall be continuously imprinted "CAUTION-FIBER OPTIC CABLE". The warning tape shall be **Teletrace** by **Vikamatic**, or equal.

B. Conduit Installation along Pipelines

1. Conduits shall be installed on one side of the trench, at least 2-inches and not more than 12-inches in from the trench wall, at a depth of 3- to 4-feet below grade along the entire pipeline route. The conduit shall not cross over the pipeline.

2. Conduits shall clear concrete structures and vaults associated with the pipeline by a minimum of one-foot.

3. Conduit shall be installed in the annular space between the carrier pipe and the casing or tunnel liner for all 2 pass tunnel or jack and bore sections of the pipeline alignment.

4. CONTRACTOR shall install marker signs on marker posts for the pipeline as indicated.

3.2 FIBER OPTIC CABLE INSTALLATION

A. General

1. The CONTRACTOR shall determine a suitable cable installation method to meet all cable installation requirements in all conduit segments. WORK shall be carried out in accordance with and consistent with the highest standards of quality and craftsmanship in the communication industry with regard to the electrical and mechanical integrity of the connections; the finished appearance of the installation; and the accuracy and completeness of documentation.

2. The CONTRACTOR shall make a physical survey of the Site for the purpose of establishing the exact cable routing and cutting lengths prior to the commencement of any WORK or committing any materials.

3. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the ENGINEER notified.

4. Fiber optic cables shall be installed in continuous lengths without intermediate splices throughout the project. Cable installation personnel shall be familiar with the manufacturer's recommended procedures including at least the following:

   a. Pulling using direct attachment to internal strength members.

   b. Cable tensile limitations and tension monitoring procedures.

   c. Cable bending radius limitations.

   d. Cable twisting limitations.

B. Cable Protection During Installation

1. Fiber optic cable shall be pulled in conduit unless indicated otherwise. Care shall be exercised to reduce the possibility of damage to the outer jacket of the fiber optic cable. The requirements herein shall be followed at a minimum, but the CONTRACTOR shall be responsible for additional measures if necessary to protect the cable. Damage shall be repaired by the CONTRACTOR as part of the WORK.

2. The CONTRACTOR shall comply with the cable manufacturer's recommended installation procedures at all times. Cable installation procedures shall conform to Belcore guidelines.

3. A cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it off the reel and into the duct. The cable shall be carefully inspected for jacket defects as it is removed from the reel. If defects are noticed, the pulling operation shall be terminated immediately and the ENGINEER notified.

4. Precautions shall be taken during installation to prevent the cable from being kinked, crushed or twisted. A pulling eye shall be attached to the cable end to pull the cable through the duct and conduit system. As the cable is pulled off the reel and into the cable feeder guide, it shall be lubricated.

5. Crushed or kinked cable shall be replaced with new cable.

6. Dynamometers or break away pulling swings shall be used to ensure the pulling line tension does not exceed the installation tension values specified by the cable manufacturer. The mechanical stress placed upon the cable during installation shall not be such that the cable is twisted and stretched. Maximum allowable cable strain during installation shall be less than 0.75 percent.

C. Lubrication: As the cable is pulled into the conduit system, it shall be coated with a water-based lubricant approved by the cable manufacturer. Lubricant shall be applied at a rate to provide a continuous 10-mil coating or as recommended by the manufacturer. Lubricant shall be **Polywater F7** manufactured by **American Polywater** or equal.

D. To accommodate long continuous installation lengths, bi-directional "center pull" techniques for pulling the fiber optic cable are acceptable.

1. From the midpoint, pull the fiber optic cable into the conduit from the shipping reel in accordance with the manufacturer's specifications.

2. When this portion of the pull is complete, the remainder of the cable shall be removed from the reel to make the inside end available for pulling in the opposite direction.

3. This shall be accomplished by hand pulling the cable from the reel and laying it into large "figure 8" loops on the ground. The purpose of the "figure 8" pattern is to avoid cable tangling and kinking.

4. The loops shall be laid carefully one upon the other to prevent subsequent tangling and shall be in a protected area.

5. The inside end of the cable is then available for installation.

6. In some cases, it may be necessary to set up a winch at an intermediate cable vault.

7. The required length of cable shall be pulled to that point and brought out of the cable vault and coiled into a figure eight.

8. The figure eight is then turned over to gain access to the free cable end. This can then be reinserted into the duct system for installation into the next segment of the conduit.

E. When power equipment is used to install fiber optic cables, the pulling speed shall not exceed 30 meters per minute. The pulling tension, bending radius, and twist limitation for fiber optic cable shall not be exceeded under any circumstances.

F. Large diameter wheels, pulling sheaves, and cable guides shall be used to maintain the appropriate bending radius. Tension monitoring shall be accomplished using commercial dynamometers or load cell instruments.

G. The pulling eye/sheath termination hardware on the fiber optic cables shall not be pulled over any sheave blocks.

H. Pulls shall be documented by a graph which is annotated with the following information:

1. Reel number

2. Station from and station to

3. Date and time

4. Explanations of abnormalities in readings or interruptions

5. Sign-off by CONTRACTOR and ENGINEER.

I. Under no conditions shall the cable be left exposed or unattended.

J. Repairs: Repair of cable jacket will not be permitted. Jacket damage shall require removal and re-installation of new cable at the CONTRACTOR's expense.

K. Installation at Pullboxes

1. Pulling of the cable shall be hand assisted at each handhole or pullbox. The cable shall not be crushed, kinked, or forced around a sharp corner. Sufficient slack shall be left at each end of the cable to allow proper cable termination.

2. The cable shall be looped in all pullboxes as indicated to provide approximately 15-feet of extra cable in the pullbox. At termination points such as at cabinets or computers, a 15-foot loop shall also be provided wherever space permits. The fiber optic cable shall be coiled and secured with cable ties in the pullbox. The CONTRACTOR shall not compromise the minimum bending radius of the fiber optic cable when preparing this stored cable slack.

3. Imprinted plastic coated cloth identification/warning tags shall be securely attached to the cables in at least two locations in each handhole. Tags shall be by **Brady** or **Thomas & Betts**.

4. When cables at each pullbox are securely racked, unused conduits and voids around conduit containing cables shall be sealed.

5. Cable Marking: At each pullbox and at each cabinet, the cable shall be visibly marked with yellow warning tape as follows:

"CAUTION - FIBER OPTIC CABLE"

L. Splicing

1. Splicing of fiber optic cable will not be permitted except in emergency conditions or if indicated otherwise. Cable runs and looping of the cable shall be provided in one continuous length. If splicing is authorized by the ENGINEER, splicing shall be by trained, authorized persons only. Any allowed splicing of fiber optic cable shall be by fusion splice only; no mechanical splices are permitted.

2. Fusion splicing equipment shall be in good working order, properly calibrated, and meeting all industry standards and safety regulations. Cable preparation, closure installation and splicing shall be accomplished in accordance with accepted and approved industry standards.

3. Splices shall be made in pullboxes and using re-enterable splice closures.

4. The average splice loss shall be 0.1 dB or less per splice. The average splice loss is defined as the summation of the loss as measured in both directions using an optical time domain reflectometer (OTDR) through the fusion splice, divided by two. No individual splice loss measured in a single direction shall exceed 0.15 dB.

5. Upon completion of a splicing operation, waste material shall be deposited in suitable containers, removed from the Site, and disposed of in an environmentally acceptable manner.

3.3 PULLBOXES

A. Field Location of Pullboxes

1. The Drawings diagrammatically indicate the desired location of pullboxes, conduit runs, and other items. Exact locations shall be determined by the CONTRACTOR based on physical size and arrangement of equipment, finished elevations, calculated cable pulling tensions, field obstructions, and the criteria below. Locations on the Drawings should be followed as closely as possible; however, pullboxes shall be located according to the following criteria:

   a. At no point shall the cable pulling tension exceed 600 pounds. If cable pulling tension is calculated to exceed 600 pounds, additional pullboxes shall be provided at no extra cost to the OWNER.

   b. The maximum distance between any two pullboxes shall not exceed 1,200 feet.

   c. Within the 1,200-feet distance, the CONTRACTOR shall install pullboxes at locations wherever the cumulative change of direction of the conduit exceeds 180 degrees.

   d. The minimum bending radius for conduit shall be 3-feet.

   e. A pullbox shall be installed on one side of a tunneled crossing. However, for any crossing which requires more than 180 degrees of conduit bends to account for elevation differences or route adjustments, a pullbox shall be provided on both sides of the crossing.

   f. Pullboxes shall be installed a minimum of 12-inches away from all structures.

B. Construction

1. The CONTRACTOR shall install the pullbox covers so that the top of the cover is flush with the restored pavement. Pullboxes installed in soil areas shall be installed so that the top of the cover is at least one-inch but not more than 4-inches above the final grade level of the restored surface to prevent accumulation of dirt, silt, and debris on the top of the hand hole cover. Pullboxes installed in areas not subject to flooding or standing water shall have a minimum of five 5-inch drainage holes in the bottom of the box.

2. CONTRACTOR shall perform conduit integrity tests for each section between pullboxes after backfilling and compaction using the test and procedures described in this Section. These tests shall be performed prior to installation of the pull rope.

3. Pullbox conduit entries shall be sealed with duct plugs to prevent the intrusion of water and debris into the pullboxes.

4. Pullboxes shall be installed on a compacted level foundation consisting of 4-inches of granular material complying with Section 31 30 00 - Earthwork.

5. Compaction around pullboxes and associated details shall be performed in accordance with Section 31 30 00 - Earthwork.

6. Upon final acceptance of the conduit system all pullboxes shall be free of debris and water and be ready for installation.

3.4 MODIFICATIONS

A. All dimensions and exact locations of underground substructures shall be field verified. Minor changes in locations of pullboxes which result in no additional costs for material or labor shall be made at no additional cost to the OWNER. However, the CONTRACTOR shall prepare proposals consisting of detailed material lists, cost estimates, and schedules for rerouting the conduit around existing unforeseen underground utilities and structures which result in additional cost. The CONSTRUCTION MANAGER will consider the proposals in accordance with the provisions of the General Conditions.

B. The CONTRACTOR shall consider the following when preparing proposals:

1. Manufactured bends shall be minimized

2. Required bends shall be less than 222 degrees

3. Clearances between conduits and other structures shall be:

Structures	Minimum Separations
Power or other foreign conduit	12-inches
Pipe for gas, oil, water, sewage	6-inches when crossing; 12-inches when parallel

3.5 CONDUIT SYSTEM CLEANING AND TESTING

A. Following the backfill placement and compaction, all conduits shall be cleared of loose material by brush and compressed air.

B. Conduit shall be tested for leakage by air testing at 5 psi, maintaining the pressure for one hour without showing any leakage.

C. Following the leakage test, a test mandrel d inch smaller than the inside diameter shall be passed through all conduits to detect alignment and deformation problems. Mandrel shall be passed in both directions.

D. Cleaning and testing of the conduit shall be performed by the CONTRACTOR and witnessed by the CONSTRUCTION MANAGER. The cleaning and testing operation shall be conducted for each conduit section between adjacent pullboxes, a section at a time, for the entire route. The results of tests shall be documented by the CONTRACTOR and signed by the CONSTRUCTION MANAGER and the CONTRACTOR.

E. The CONTRACTOR shall provide a 5 Day advance notice of the schedule and location of test to the CONSTRUCTION MANAGER.

F. The CONTRACTOR shall remove and replace conduit which fails either test and shall repeat the test.

3.6 FIBER OPTIC CABLE TESTING

A. General: The CONTRACTOR shall perform pre-installation and post-installation FOC tests. The CONSTRUCTION MANAGER shall be notified a minimum of 10 Days in advance so that these tests are witnessed. All test equipment shall be traceable to LIST standards.

B. Test equipment: The CONTRACTOR shall use the following to perform pre-installation and post-installation FOC tests:

1. **Optical Time Domain Reflectometer (OTDR):** The OTDR shall be laser precision, **ALT Inc MODEL 5200 LRFL**, or equal.

C. Pre-Installation Tests

1. The purpose of these tests is to perform acceptance tests on the cable prior to installation to verify that the cable conforms to the manufacturer's specifications, and is free of defects, breaks and damages by transportation and manufacturing processes.

2. Prior to removal of each cable from the delivery reel, all optical fibers within the cables shall be tested by the CONTRACTOR using an OTDR. The OTDR tests shall consist of end-to-end length and fiber attenuation (dB/km) measurements to ensure proper performance of the fiber optic cable. The tests shall be performed from both ends of each fiber to ensure complete fiber continuity within the cable structure.

3. Pre-installation, "on-reel" test results shall be compared with the manufacturer's test report delivered with the cable. Gross dissimilarities shall be noted and remedied between the contractor and manufacturer In all cases, all fibers must meet the optical attenuation specifications prior to cable installation.

4. The CONTRACTOR shall perform tests on all reels of cable. The CONSTRUCTION MANAGER shall be notified a minimum of 15 Days prior to any test.

5. The CONTRACTOR shall document each test and submit the report to the CONSTRUCTION MANAGER for review. Documentation shall consist of both hard copy and 32-inch electronic disk complete with all application software.

6. Cable shall not be installed until the CONSTRUCTION MANAGER has reviewed the test report.

7. Maximum allowable attenuation is 0.5 dB/km at 1310 and 1550 nm. The CONTRACTOR shall replace any cable in which any fiber does not meet this requirement.

D. Post-Installation Tests: After FOC has been installed the following tests shall be performed:

1. A recording OTDR shall be used to test for end-to-end continuity and attenuation of each optical fiber. The OTDR shall be equipped with a 1310 nm and 1550 nm light source for the single mode fiber (SMF). The OTDR shall have an X-Y plotter to provide a hard copy record of each trace of each fiber. The OTDR shall be equipped with sufficient internal masking to allow the entire cable section to be tested. This may be achieved by using an optical fiber pigtail of 30-feet or more to display the required cable section.

2. The maximum permissible end-to-end loss shall be 0.5 dB/km. The CONTRACTOR shall replace any cable in which any fiber does not meet this requirement.

3. The OTDR shall be calibrated for the correct index of refraction to provide proper length measurement for the known length of reference fiber.

4. A transmission test shall be performed with the use of a 1310 and 1550 nm stabilized light sources and 1310 nm/1550 nm power meters for SMF. This test shall be conducted in both directions on each fiber of each cable.

5. Hard and electronic copy of test documentation shall be submitted to the CONSTRUCTION MANAGER. The documentation shall include the trace plot, index, dB/km loss, cable length, date and time of test, wavelength, pulse width, the test site, cable ID, fiber number and type, and operator's initials. The CONTRACTOR shall compare the pre-installation test results to the post-installation results. If a deviation of greater than one dB occurs, the CONSTRUCTION MANAGER shall be notified in writing by the CONTRACTOR, and the cable shall be removed and replaced at no additional cost to the OWNER.

6. Upon completion of the previous tests all FOC coils shall be secured with ends capped to prevent intrusion of dirt and water.

E. Required OTDR Trace Information

1. All traces shall display the entire length of cable under test, highlighting any localized loss discontinuities (installation-induced losses and/or connector losses). The trace shall display fiber length (in kilofeet), fiber loss (dB), and average fiber attenuation (in dB/km) as measured between two markers placed as near to the opposite ends of the fiber under test as is possible while still allowing an accurate reading. Care shall be taken to ensure that the markers are placed in the linear region of the trace: away from the front-end response and far-end Fresnel reflection spike. Time averaging shall be used to improve the display signal to noise ratio. The pulse width of the OTDR shall be set to a sufficient width to provide adequate injected power to measure the entire length of the fiber under test.

2. If connectors exist in the cable under test, then two traces shall be recorded. One trace shall record the fiber loss (dB) and average attenuation (dB/km) of the entire cable segment under test, including connectors. The second trace shall display a magnified view of the connector regions, revealing the connector losses (dB). All connector losses shall be measured using the 5 point splice loss measurement technique.

3. The OTDR trace shall also include the following information:

   a. The date and time of the test

   b. The cable ID number

   c. The cable segment ID number

   d. The fiber color or sub-cable number

   e. Launch point connector number

   f. The optical wavelength used for the test

g. The refractive index setting of the OTDR

h. The pulse width setting of the OTDR

i. The averaging interval of the test

3.7 RECORD DRAWINGS

A. In compliance with Section 01 77 00 – Project Closeout, the CONTRACTOR shall upon completing the construction of the fiber optic system, shall submit to the CITY Record Drawings showing the following:

1. Horizontal alignment of fiber optic conduit

2. Vertical alignment of fiber optic conduit

3. Location of all pullboxes using Station Number, and the exact Northing and Easting of each pullbox using the North American Datum (NAD) 83 coordinate system.

Appendix A
Special Project Requirements

Location	Segment[1]	Cable Type	Drawing	Requirement

END OF SECTION

SECTION 31 10 00 – SITE PREPARATION

PART 1 -- GENERAL

1.1 SUMMARY

A. In its initial move onto the Site, the Contractor shall protect existing fences, houses and associated improvements, streets, and utilities downslope of construction areas from damage due to boulders, trees, or other objects dislodged during the construction process and clear, grub, strip; and regrade certain areas, in accordance with the Contract Documents. The Contractor shall also inspect the Site conditions and review maps of the Site and facilities delineating the Owner's property and right-of-way lines.

B. Contractor shall provide all labor, materials, equipment, and incidentals required to perform all clearing and grubbing as shown and as specified herein. Contractor shall pay for all disposal fees. The Work covered by this Section consists of removing and disposing of all trees, stumps, bush, roots, shrubs, vegetation, logs, rubbish, and other objectionable material from the Site, as required to perform the Work.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

02 41 00	Demolition

PART 2 -- PRODUCTS – NOT USED

PART 3 -- EXECUTION

3.1 SITE ACCESS

A. The Contractor shall develop any necessary access to the Site, including access barriers to prohibit entry of unauthorized persons.

B. **Utility Interference:** Where existing utilities interfere with the Work, notify the utility owner and the Engineer before proceeding in accordance with the General Conditions.

3.2 CLEARING, GRUBBING, AND STRIPPING

A. Limits of clearing and grubbing shall be all areas within the Contract limits, except as otherwise shown. Damage outside these limits caused by Contractor's operations shall be corrected at Contractor's expense.

B. Construction areas shall be cleared of grass and weeds to at least a depth of 6-inches and cleared of structures, pavement, sidewalks, concrete or masonry debris, trees, logs, upturned stumps, loose boulders, and any other objectionable material of any kind which would interfere with the performance or completion of the Work, create a hazard to safety, or impair the subsequent usefulness of the Work, or obstruct its operation. Loose boulders within 10-feet of the top of cut lines shall be incorporated in landscaping or removed from the Site. Trees and other natural vegetation outside the actual lines of construction shall be protected from damage during construction.

C. Within the limits of clearing, the areas below the natural ground surface shall be grubbed to a depth necessary to remove stumps, roots, buried logs, and other objectionable material. Septic tanks, drain fields, and connection lines and any other underground structures, debris or waste shall be removed if found on the Site in accordance with the requirements of Section 02 41 00 – Demolition. Objectionable material from the clearing and grubbing process shall be removed from the Site and wasted in approved safe locations.

D. The entire area to be affected by construction shall be stripped to a depth of 3 feet below the existing ground contours. The stripped materials shall be stockpiled and incorporated into landscaped areas or other non-structural embankments.

E. Stockpile topsoil in areas where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of mineral subsoil, debris, and stones larger than two inches in diameter.

F. Unless otherwise indicated, native trees larger than 3-inches in diameter at the base shall not be removed without the Engineer's approval. The removal of any trees, shrubs, fences, or other improvements outside of rights-of-way, if necessary for the Contractor's choice of means and methods, shall be arranged with the owner of the property, and shall be removed and replaced, as part of the Work.

G. Burning on-site shall not be performed.

H. In order to avoid additional removal or damage, existing trees and shrubs shall be trimmed as required. Trimmed or damaged trees shall be treated and repaired by persons with experience in this specialty that are approved by Engineer. Trees and shrubs intended to remain, that are damaged beyond repair or removed, shall be replaced by Contractor, at no additional cost to the Owner.

I. Control air pollution caused by dust and dirt and comply with governing regulations.

3.3 OVEREXCAVATION, REGRADING, AND BACKFILL UNDER FILL AREAS

A. After the fill areas have been cleared, grubbed, and excavated, the areas to receive fill will require overexcavation, regrading, and backfill, consisting of the removal and/or stockpiling of undesirable soils. The ground surface shall be recontoured for keying the fill and removing severe or abrupt changes in the topography of the Site. Overexcavated volumes shall be backfilled to a level 3 feet below the existing ground contours.

3.4 PROTECTION OF EXISTING TREES

A. GENERAL

1. Flagging of Existing Trees: Flag trees to remain and to be removed with a bright and different colored ribbon. Notify the Engineer at least 48 hours prior to commencing of Work to verify all trees that are flagged.

2. Do not park any vehicles or equipment, nor store any materials or stockpiled soil, nor dispose of building materials, chemicals, petroleum products or other detrimental substances within drip line of tree. Protect trees from flame, smoke and heat. Construction access to site shall not occur beneath drip line of trees.

B. EXISTING TREES TO REMAIN

1. Protect root systems from smothering. Restrict foot traffic to prevent excessive compaction of soil over root systems.

2. Individual trees and areas shown to remain shall be protected by six (6) foot high chain link fence. Install fencing before site preparation, grading and clearing and grubbing operations.

3. Under no circumstances shall the Contractor remove existing trees designated to remain for his/her convenience or ease of construction.

4. Prior to installation, stake the location of protection fencing for approval by the Engineer. Location stakes or marking shall be placed not greater than ten (10) feet on-center.

C. EXCAVATION AROUND TREES

1. Excavate within drip line of trees only where shown.

2. Where trenching for utilities is required within drip line, tunnel under or around roots by hand digging. Do not cut main lateral roots or tap roots. The Contractor shall notify the Engineer prior to cutting roots over 6-inch diameter. Roots up to and including ¾-inch shall be cut by hand saws. Do not leave roots exposed to sun or drying for more than 24 hours. Protect all exposed roots with moist organic mulch or burlap and backfill as soon as possible.

3. Where excavating for new construction is required within drip line of tree, excavate by hand to minimize damage to roots and perform as follows:

   a. Use narrow tine spading forks and comb soil to expose roots.

   b. If main lateral roots are immediately adjacent to location of new construction, cut roots three (3) inches from new construction.

   c. Do not allow exposed roots to dry out before permanent backfill is placed.

   d. Provide temporary earth cover, or pack with peat moss and wrap with burlap.

   e. Water and maintain in moist condition until covered with backfill.

D. TRIMMING OF EXISTING TREES

1. Engage a qualified tree surgeon to remove branches from tree. No pruning unless approved and directed by the Engineer.

2. Pruning: Cut branches with sharp pruning instruments and do not break or chop. Prune flush with trunk surface.

3. Trimming: Symmetry of the tree shall be preserved; no stubs or splits or torn branches left; clean cuts shall be made close to the trunk or large branch. Spikes shall not be used for climbing live trees. All cuts over 1-1/2-inches in diameter shall be coated with an asphaltic emulsion material.

END OF SECTION

SECTION 31 23 19 – DEWATERING

PART 1 -- GENERAL

1.1 SUMMARY

A. Design, installation, operation, and removal of dewatering system shall comply with current safety and environmental regulations.

B. The Contractor shall lower and control groundwater levels and hydrostatic pressures to permit construction work to be performed in the dry in accordance with the Contract Documents. Control of surface water shall be considered as part of the work under this specification.

C. The Contractor shall secure all necessary permits to complete the requirements of this Section of the Specifications.

D. The Contractor shall be responsible for providing all materials, equipment, labor, and services necessary for dewatering in a manner compatible with construction methods and site conditions.

E. The Contractor shall implement an erosion and sedimentation control plan before excavation work begins.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
31 30 00	Earthwork

1.3 REQUIREMENT

A. Dewater system shall be of sufficient size and capacity necessary to lower and maintain groundwater level to an elevation at least one foot below the lowest excavation depth and to allow material to be excavated in a reasonably dry condition.

B. Maintain stability of excavation sides and base.

C. Prevent loss of fines, seepage, boils, quick conditions or softening of foundation strata.

D. Maintain dry and stable subgrade for subsequent construction operations.

E. Provide adequate control of surface and subsurface water such that:

1. Stability of sides and base of excavation is not adversely affected.

2. Erosion is controlled.

3. Flooding of excavations or damage to structures does not occur.

4. Surface water drains away from excavations and other work areas.

F. Preclude damage to adjacent properties, buildings, structures, utilities, installed facilities and other work.

G. Assume sole responsibility for the dewatering system and for any loss or damage resulting from inadequacy or failure of the system. Perform work necessary to repair the damages at no additional cost to the Owner.

1.4 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. All required permits.

C. Prior to commencement of excavation, the Contractor shall submit a detailed plan and operation schedule for dewatering of excavations. The detailed plan shall include mitigation measures to prevent settlement of nearby structures and a contingency plan for restoring nearby structures if settlement is observed as a result of the Contractor's dewatering operations. The Contractor may be required to demonstrate the system proposed and to verify that adequate equipment, personnel, and materials are provided to dewater the excavations at all locations and times. The Contractor's dewatering plan is subject to review by the Engineer. The plan shall be signed and sealed by a qualified Professional Engineer licenses in Washington and include the following:

1. Drawings and data showing the dewatering system, monitoring program, and erosion and sedimentation control plan to be employed.

2. Detailed description of the dewatering system, including arrangement, location, depth and capacities of the system components, installation details, and operation and maintenance procedures.

3. Description of the monitoring program, including instrument type, location, installation details, monitoring criteria, and operation and maintenance procedures.

4. A written report including control procedures to be adopted if dewatering problems arise.

5. Design calculations demonstrating adequacy of the dewatering system and selected equipment for intended applications.

6. Description of methods to be employed for disposal of removed water.

1.5 QUALITY CONTROL

A. It shall be the sole responsibility of the Contractor to control the rate and effect of the dewatering in such a manner as to avoid all objectionable settlement and subsidence.

B. All dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

C. All structures or facilities that are located within the radius of influence of the Contractor's dewatering operation shall have reference points established and observed at frequent intervals to detect any settlement which may develop. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor. The Contractor shall survey, record and report the reference points on a daily basis, and submit the written log to the Engineer at the completion of construction. The Engineer shall be immediately notified should any sign of settlement is observed. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

D. The dewatering field supervisor shall have a minimum of five years of experience related to dewatering work and have completed at least three projects of similar scope and complexity.

PART 2 -- PRODUCTS

2.1 EQUIPMENT

A. Dewatering, where required, may include the use of well points, sump pumps, temporary pipelines for water disposal, rock or gravel placement, and other means. Sufficient standby pumping equipment and other materials shall be maintained on the Site to ensure continuous dewatering operation.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

A. The Contractor shall provide all equipment necessary for dewatering. It shall have on hand, at all times, sufficient pumping equipment and machinery in good working condition and shall have available, at all times, competent workmen for the operation of the pumping equipment. Adequate standby equipment shall be kept available at all times to insure efficient dewatering and maintenance of dewatering operation during power failure.

B. Install a dewatering system with sufficient capacities to lower and control groundwater level in order to permit excavation, structure construction, and backfilling to be performed in dry conditions. Ensure the dewatering system is adequate to pre-drain water-bearing strata and to maintain groundwater table below the bottom of structure foundations, utilities, and other excavations.

C. Dewatering for structures and pipelines shall commence when groundwater is first encountered, and shall be continuous until such times as water can be allowed to rise and dewatering is no longer required in accordance with the provisions of this Section or other requirements.

D. At all times, site grading shall promote drainage. Surface runoff shall be diverted from excavations. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation, drained to sumps, and be pumped or drained by gravity from the excavation to maintain a bottom free from standing water.

E. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.

F. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock.

G. The Contractor shall maintain the water level below the bottom of excavation in all work areas where groundwater occurs during excavation construction, backfilling, and up to acceptance.

H. Flotation shall be prevented by the Contractor by maintaining a positive and continuous removal of water. The Contractor shall be fully responsible and liable for all damages which may result from failure to adequately keep excavations dewatered.

I. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means used to prevent pumping of fine sands or silts from the subsurface. A continual check by the Contractor shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.

J. The Contractor shall dispose of water from the Work in a suitable manner without damage to adjacent property and negatively impacting work areas. Contractor shall be responsible for obtaining any permits that may be necessary to dispose of water. No water shall be drained into work built or under construction without prior consent of the Engineer. Water shall be filtered using an approved method to remove sand and fine-sized soil particles before disposal into any drainage system.

K. The Contractor shall utilize all necessary erosion and sediment control measures to avoid construction related degradation of the natural water quality.

L. The Contractor shall implement correction measures if dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system.

M. The Contractor shall immediately repair damages to adjacent facilities caused by dewatering operations.

N. The Contractor shall remove the dewatering system and monitoring instruments as directed by the Engineer when groundwater control is no longer required. The Contractor shall ensure compliance with all conditions of regulating permits and obtain written approval from the Engineer before discontinuing operation of dewatering system.

O. The release of groundwater to its static level shall be performed in such a manner as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted backfill and prevent flotation or movement of structures, pipelines, and sewers.

P. Dewatering of trenches and other excavations shall be considered as incidental to the construction of the Work and all costs thereof shall be included in the various contract prices in the Bid Forms unless a separate bid item has been established for dewatering.

END OF SECTION

SECTION 31 23 33 – TRENCH BEDDING AND BACKFILL

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes

1. The Contractor shall provide all labor, materials, and equipment as necessary to complete excavating, backfilling, and compacting of trenches as required for installation of storm sewer, sanitary sewer, and water pipelines, and all related appurtenances in accordance with the Contract Documents.

2. The Work includes:

a. Removal of surface materials and structures

b. Excavation from the trench of all materials of whatever kind encountered so that pipes and structures can be laid to alignment and depth required.

c. Support of the adjoining ground or structures

d. Stockpiling and disposal of excess excavated material

e. Control of surface and subsurface water in trenches

f. Temporary railings, coverings and enclosures for excavations

g. Removal and replacement of unsuitable material

h. Backfilling of trenches

i. Restoration of surfaces

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
01 45 00	Quality Control
31 10 00	Site Preparation
31 23 19	Dewatering
31 30 00	Earthwork

B. Geotechnical Engineering Report, Carson Water Treatment Plant; Rhino One

C. Reference Standards

American Society for Testing and Materials	
ASTM C33	Standard Specification for Fine Aggregate Sand

ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150	Standard Specification for Portland Cement - Type IA
ATSM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash or Calcined Natural Pozzolan for use in Concrete
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2434	Standard Test Method for Permeability of Granular Soils (Constant Head)
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2922	Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D4253	Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.03 SUBMITTALS

A. Submittals to be provided, in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Product Data

1. Soils and Aggregates

a. Submit to the Engineer a list of sources of materials including sand, gravel, borrow materials, and concrete aggregates.

b. Provide samples, test results, sieve analyses and reports for preliminary approval of materials.

c. Preliminary approval of material does not constitute general acceptance. Acceptance depends upon satisfactory field test results and performance in place.

2. Other Products and Materials

a. Contractor shall submit product data for all other product and materials, identified in this Section, to be furnished by the Contractor.

C. Test and Evaluation Reports

1. The Contractor shall submit material testing and compaction testing reports to the Engineer. Test reports shall indicate the specific test location, and or station information, date and time, and other applicable information.

2. Test reports are to include, but not limited to; soil classifications according to ASTM D 2487, moisture-density curves, sieve analyses, field densities, concrete slump, concrete air content, and concrete strength tests.

PART 2 -- PRODUCTS

2.01 BACKFILL MATERIAL REQUIREMENTS

A. General

1. Satisfactory backfill soils shall be selected or shall be processed and classified as GW, GP, GM, GC, SW, SP, SM, and SC according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3-In in any dimension, debris, waste, frozen material, vegetation and organic matter, and other deleterious matter.

2. Unsatisfactory backfill soils include MH, CH, OL, OH, and PT according to ASTM D 2487, or a combination of these groups. Unsatisfactory backfill soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at the time of compaction.

2.02 MATERIALS TESTING

A. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D2487.

2. The Contractor shall be bound by applicable provisions of ASTMD 2487 in the interpretation of soil classifications.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 6913 - Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

C. Atterberg Limits testing of soil will be performed using ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

D. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

E. Moisture-density curves for each type of material from each source of material to be compacted to a specified density shall be performed in accordance with ASTM D698.

F. Sieve analysis for all granular material shall be performed in accordance ASTM C136

2.03 PIPE BEDDING MATERIALS

A. Pipe zone bedding and backfill shall consist of well-graded, crushed, processed, or naturally occurring granular material. It shall be free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact and shall meet the following gradation requirements.

Sieve Size	Percent Passing
1-1/2”	99-100
1”	75-100
5/8”	50-100
No 4	20-80
No 40	3-24
No 200	10.0 max
Sand Equivalent	35 min

B. Pipe zone bedding shall be placed beneath, adjacent to, and for at least 2-feet above the pipe zone.

2.04 TRENCH BACKFILL MATERIALS

A. Withing roadway alignments, the remainder of the trench backfill shall be aggregate base meeting the requirements of Section 32 11 13 2.01.

B. Outside of structural improvement areas (e.g., roadway alignments or building pads), trench backfill placed above the pipe zone may consist of general fill materials that are free of organics and materials over 6 inches in size.

2.05 TRENCH DRAIN MATERIAL

A. Backfill for subsurface trench drains and for a minimum shall consist of drain rock meeting the following gradation requirements:

Sieve Size	Percent Passing
1”	99-100
3/4"	80-100
3/8”	0-40
No 4	0-4

No 200	0-2

2.06 FLOWABLE FILL

A. Flowable fill shall be a mixture of cement, fly ash, fine sand, water, and air having a consistency which will flow under a very low head and is self-compacting.

B. Unshrinkable flowable fill materials shall conform to the following properties:

Compressive Strength at 28 Days (psi)	Slump (inch)	Entrained Air (percent by Volume)	Maximum Aggregate Size (inch)	Minimum Cement (lbs/ft^3)
Minimum – 20 Maximum – 60	4+/-1	6.0 – 8.0	0.25-in	1.8 lbs/ft^3

a. Portland Cement – ASTM C 150– Type IA

b. Fine Aggregate – ASTM C 33.

c. Water – ASTM C 94., clear, free from injurious amounts of oil, acid, alkali, organic matter, sediment or other substances harmful to the mixing and curing of concrete.

d. Air Entraining Admixtures – ASTM C260.

e. Chemical Admixtures – ASTM C494, including water reducing agents, retarders and accelerators.

f. Fly Ash – ASTM C 618. Class C or F.]

PART 3 -- EXECUTION

3.01 GENERAL

A. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the Work.

B. The removal of such materials shall conform to the lines and grades indicated or ordered.

C. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site prior to performing any excavation or placing any fill.

D. The Contractor shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.

E. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable safety requirements and regulations.

F. The Contractor shall provide quantity surveys where so required to verify quantities for Unit Price Contracts.

G. Surveys shall be performed prior to beginning Work and upon completion by a surveyor licensed in the State where the Site is located.

3.02 PREPARATION

A. Clear the surface of the ground or road within the working area.

B. Dispose of refuse in a manner satisfactory to the Engineer.

C. Windrow reusable gravel and keep it separate from the remainder of the excavated material so that it can be replaced when the backfilling operation has been completed.

D. Strip topsoil and stockpile adjacent to, but separate from, gravel and sub soil.

E. Width of stripping shall be sufficient to permit excavation, pipelaying, backfilling and replacement of topsoil without mixing of materials and without loss of topsoil.

F. Precutting Paved Surfaces

1. Saw cut pavement in straight lines parallel to the trench centerline.

2. Cut width shall not exceed the specified maximum trench width at the ground surface.

3. Prevent the destruction of pavement in excess of the allowable width, by supporting the trench, by sheeting or other means.

4. Cutting pavement in excess of the allowable width is allowed if the nature of the soil is such that sheeting of the trench wall is impractical.

5. Dispose of cut pavement.

6. Where, in the opinion of the Engineer, the existing pavement is of such condition that precutting of pavement is not necessary, the pavement may be cut by trenching equipment.

3.03 DISPOSAL

A. All materials on site whether stockpiled, stored or excavated are the property of the Owner, and the Owner reserves the right to keep any part or all of the material.

B. The Contractor shall dispose of debris, waste, unsuitable material, rock or excess material in accordance with these Specifications, and all applicable Federal, State/Provincial, and local regulations.

C. The Contractor shall dispose of all materials at sites to be obtained by the Contractor.

3.04 EXCAVATION

A. Depth - Excavate the trench to a depth sufficient to lay the pipe as shown on the drawings. If any part of the trench bottom is excavated in error below the specified grade, correct with approved materials compacted as specified under Pipe Bedding, at the Contractor's expense.

B. Width - Excavate trench width at the bottom such that the pipe can be laid and jointed as specified and backfill placed and compacted as specified. Trench width dimensions are specified under installation of pipe. Increase trench widths to allow placing of timber supports, sheeting and bracing, but do not exceed the maximum trench width shown on drawings. Make trench walls vertical to 12 in above the top of the pipe and maintain widths above this level within limits shown on the drawings or in accordance with safety regulations. Pipe design is dependent upon the type of bedding specified and the class of backfilling in the pipe zone, as well as the width of the trench. If the Contractor uses trenching equipment or trenching methods that result in a wider trench than specified under the installation of pipe, then corrective work shall be performed as required by the Engineer, at the Contractor's expense. The corrective work may take the form of either or both of the following:

   1. Supply and installation of a higher class of bedding and backfilling in the pipe zone

   2. Supply and installation of a stronger class pipe

C. Length - Excavate trenches only as far in advance of pipelaying as safety and traffic conditions permit and as far as the Engineer shall allow.

D. Excavate so that the pipe can be laid to the line and grade as shown on drawings, or as established by the Engineer. Excavations for pipe bells and welds shall be made as required.

E. Stockpile material excavated alongside the trench in authorized working areas in a manner that will not endanger the Work, hinder pedestrian or vehicle traffic, block surface drainage or obstruct access to other utilities. Where excavated material cannot be piled along the trench in compliance with the above restrictions, remove it from the site and stockpile at an acceptable location for return to the trench for backfilling. Do not stockpile excavated material over existing pipelines or rights-of-way.

F. Dispose of waste or surplus material as per Article 3.03.

G. The expense of removing water from trenches, regardless of origin, is the responsibility of the Contractor.

H. Common Excavation

   1. Excavation of materials, with the exception of surface gravel, pavement or rock, is classified as common excavation.

   2. In ledge rock, boulders or large stones, overexcavate 6-in below the pipe level to allow for additional bedding material.

I. Rock Excavation

   1. Rock is either single boulders, pieces of concrete or masonry with a volume in excess of 1/3 yd^3 or any material that cannot be removed by a tracked machine, having a bucket capacity of 1.25 to 1.5 yd^3 and which requires for its removal, drilling and blasting or breaking up with a power operated hand tool

2. No soft or disintegrated rock which can be removed with a hand pick; no material which can be ripped with a crawler tractor having a rated horsepower of 200 to 249; no loose or previously blasted rock or broken stone and no rock exterior to the minimum limits for measurement allowed, which may fall into the excavation will be measured or allowed.

3. Frozen material is not classified as rock

4. Remove rock to a disposal site as per Article 3.03.

J. Unsuitable Material

1. Unsuitable material is material in the trench at subgrade that is unstable or which contains ashes, cinders, organic material, and large pieces of inorganic material or is otherwise unsuitable and which in the judgment of the Engineer, should be removed

2. Excavate and remove unsuitable material to a width and depth ordered by the Engineer. Backfill the subgrade with an approved material compacted in 6-in lifts to provide a continuous bearing for pipes. Replacement material shall be washed rock, pit-run gravel or well graded sandy gravel

3. Dispose of unsuitable material as per Article 3.03.

4. Payment will be made for removal and replacement of unsuitable material if the Work is ordered by the Engineer

5. Material that becomes unstable or unsuitable through the Contractor's failure to divert surface water or control ground water in the trench shall be excavated and removed as waste material and replaced with approved material at the expense of the Contractor

K. Temporary Protective Structures

1. Temporary protective structures, bracing, shoring and sheeting are the responsibility of the Contractor and shall be designed by a Professional Engineer registered/licensed in the jurisdiction of the Work.

2. Observe safety regulations with regard to protection of the Work, property, structures adjacent to the Work and maintenance of the trench widths.

3. When closed sheeting is required it shall be installed such that adjacent soil cannot enter the trench either below or through sheeting.

4. Increase trench widths as necessary to allow placing of supports, sheeting and bracing, but do not exceed the maximum trench widths shown on the drawings, or provide for corrective measures.

5. Where damage to adjacent structures will not result, remove temporary protective structures, and backfill as specified for the pipe zone and the trench.

6. Leave temporary structures in place where damage to adjacent structure may result or if ordered by the Engineer.

L. Trench Shield

1. If a moveable trench shield is used during excavation operations, the trench width shall be wider than the shield such that the shield is free to be lifted and then moved horizontally without binding against the trench sidewalls and causing sloughing or caving of the trench walls.

2. If the trench walls cave or slough, the trench shall be excavated as an open excavation with sloped sidewalls or with trench shoring, as indicated and as required by the pipe structural design.

3. If a moveable trench shield is used during excavation, pipe installation, and backfill operations, the shield shall be moved by lifting the shield free of the trench bottom or backfill and then moving the shield horizontally.

4. The Contractor shall not drag trench shields along the trench causing damage or displacement to the trench sidewalls, the pipe, or the bedding and backfill.

M. Special Supports

1. Construct special supports of timber, concrete or other material, as ordered by the Engineer, where the bottom of the trench is unstable and over excavation is judged by the Engineer to be uneconomical

2. Payment will be allowed as extra work if special supports are ordered by the Engineer

N. Interfering Services

1. Provide for the uninterrupted flow of all watercourses, sewers and drains encountered during the Work.

2. Support existing watermains, sewer pipes, gas lines and other buried facilities to protect them from damage.

3. Repair and make good at the Contractor’s expense, any damage which may occur to any watermain, sewer pipe, gas line or other buried facilities and to any electrical conductor, cable, sidewalk, curb or structure.

4. Determine the locations of all structures, pipes, manholes and valves by contact with the Owner and the examination of drawings. If necessary, explore and excavate for such purposes.

3.05 TRENCH CROSSINGS

A. Existing pipelines shall be exposed by hand digging and no mechanical excavation shall be undertaken within 3 ft of an existing pipeline.

B. Give notice to owners of pipelines at least 48hours prior to commencement of work on pipeline crossings. Excavation cannot commence until the representative of the pipeline is present or until written authorization from the pipeline owner is received.

3.06 PIPE BEDDING

A. Pipe bedding shall be in accordance with the drawings and with the specifications for installation of the pipe.

B. Do not proceed with placing pipe bedding until the Engineer has inspected the trench.

3.07 BACKFILLING IN THE PIPE ZONE

A. The pipe zone is defined as that part of the trench from the bottom of the pipe bedding to 12-in the top of the pipe, or above the top of the highest pipe in a combined trench.

B. Backfilling in the pipe zone shall be in accordance with the drawings and with the specifications for installation of the pipe.

3.08 TRENCH BACKFILL

A. Trench backfill is defined as backfill above the pipe zone.

B. Do not proceed with trench backfill until the Engineer has inspected and approved the bedding and backfill in the pipe zone.

C. Place backfill in a dry trench.

D. Place backfill by rolling down a slope in the trench or lower by machine. Prevent backfill from dropping vertically.

E. Backfill as close as possible to pipe laying operations so that trenches are left open no longer than absolutely necessary.

F. Plan the backfilling operation so that exposure of the backfill material to frost is kept to a minimum. Use no large frozen chunks of soil as backfill.

3.09 FIELD TESTING

A. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum density at optimum moisture content will be determined in accordance with Method C of ASTM D1557.

2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D4253 and D4254.

3. Field density in-place tests will be performed in accordance with ASTM D1556, ASTM D2922, or by such other means acceptable to the Engineer.

B. Testing Frequencies

1. Pipe Zone Backfill - one test for every 300 ft of trench length.

2. Trench Backfill - one test for every 300 ft of trench length, and 1.5 ft fill depth.

C. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to ensure compliance.

2. Subsequent testing to show compliance shall be by the Contractor and paid by the Contractor.

3.10 RESTORATION

A. Restore or replace all fences, poles or other property and surface structures damaged or removed during the course of The Work to a condition equal to that before The Work began, furnishing all labour and materials at the Contractor's expense.

B. Restore trench surfaces to their original level and conditions after backfilling or as detailed on the drawings.

C. Restore other working areas that were affected by the construction operation by re-grading, re-gravelling and pavement repair as necessary to restore these surfaces to their original level and condition.

3.11 RELEASES

A. The Contractor shall submit to the Engineer, prior to the release of holdback, signed clearances on forms approved by the Engineer, from all landowners, tenants and authorities, acknowledging that the Contractor has performed the work to their satisfaction.

END OF SECTION

SECTION 31 30 00 – EARTHWORK

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall perform earthwork as indicated and required for construction of the Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 45 00	Quality Control
01 71 13	Mobilization
31 23 19	Dewatering

C. Geotechnical Engineering Report, Carson Water Treatment Plant; Rhino One

D. Reference Standards

American Society for Testing and Materials	
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort 56,000 ft-lbf/ft^3
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D2922	Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
ASTM D3017	Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth)
ASTM D4253	Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4254	Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D6913	Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth)

1.3 MEASUREMENT AND PAYMENT

A. Common Excavation to Compacted Embankment

Common Excavation to Compacted Embankment shall include all common excavation from Project borrow areas, and placement of the resulting common fill in compacted embankment as noted on the Contract Drawings This item includes all loading, hauling, placing, grading and trimming of the embankment areas and all compaction as required for the compacted embankment areas as specified.

Payment: Unit price per cubic yard of excavation

Measurement: Actual volume of common excavation as measured in the cut area. The Engineer will undertake a topographic survey of the cut area immediately before and after excavation for the purpose of this measurement item. The initial survey will occur after stripping. The Engineer will also perform a survey of the fill areas before and after filling to verify the fill volume.

1.4 CONTRACTOR SUBMITTALS

A. Submittals shall be provided to show conformance to these Specifications and the Plans for Construction. Submittals shall be provided at least 10 working days prior to the installation of materials, unless noted otherwise.

B. Materials Testing Laboratory

1. Provide accreditations for materials testing laboratories indicating they meet the qualifications to perform the required laboratory tests specified in this Section.

2. Accreditations shall be approved prior to testing any materials that will be included in the Borrow Assessment Report with intentions to be incorporated into the Work.

C. Samples

1. The Contractor shall submit samples of materials proposed for the Work in conformance with the requirements of Section 01 33 00 – Submittal Procedures.

2. Samples will be collected and shipped in accordance with appropriate ASTM or AASHTO standards. Sufficient quantity and sample size shall be collected as determined by the testing laboratory.

D. Borrow Assessment Report

1. Submit a Borrow Assessment Report (BAR) for all on-site and off-site borrow materials that will be used in the Project. The BAR shall be revised throughout construction to include new borrow sites if they are needed and to meet the minimum testing frequencies specified in these Specifications. At a minimum, the BAR should include the following:

a. Proposed borrow source locations including figures showing the borrow site locations and which areas of the borrow site material will be taken from.

b. Sample locations with detailed descriptions and geographic reference (i.e., coordinate points).

c. Laboratory test results completed and reported in accordance with the respective ASTM Standard for each test type.

d. Moisture-density curve for each soil sample.

E. Aggregates and Riprap

1. Provide current documentation from the supplier regarding conformance of the subject materials to the requirements of these Specifications.

2. For aggregates, provide gradation analyses performed on representative samples of the proposed source.

F. Materials Management Plan

1. The Contractor shall submit a Materials Management Plan documenting processes used to mechanically screen or crush materials to meet these Specifications, if required.

G. Pre-construction Photographs or Videotape

1. Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

2. Provide captions for each photograph that includes the item being shown, location, and direction.

H. Excavation Plan

1. Indicate sequencing of operations for material excavation and how materials will be managed, stockpiled, and placed after excavated.

2. Provide both a written description and figures to illustrate the sequencing. At a minimum, descriptions and figures should be provided for each stage of construction. Multiple figures for each stage shall be provided, if necessary, to adequately convey the plan.

3. Include a list of equipment being used to perform excavations and other necessary information to make clear how the work will be performed. Provide adequate cross-references to the Embankment Plan.

I. Embankment Plan

1. Indicate sequencing of operations for embankment construction and fill placement. This should include, at a minimum, placement/compaction of lifts and benching methods at transitions to existing grade.

2. Provide both a written description and figures to illustrate the sequencing.

J. Include list of equipment being used to place fill and other necessary information to make clear how the work will be performed. Provide adequate cross-references to the Excavation Plan.

1.5 QUALITY CONTROL AND QUALITY ASSURANCE TESTING

A. Testing Agencies

1. The Contractor shall engage and retain a Geotechnical Testing Agency for all Quality Control material and field testing, as specified in this Section. The Testing Agency qualifications shall be reviewed by the Engineer. The Contractor shall bear all costs for material and field testing, as specified in this Section.

2. Soils testing laboratories shall be AASHTO or USACE Materials Testing Center accredited.

PART 2 -- PRODUCTS

2.1 FILL AND BACKFILL MATERIAL REQUIREMENTS

A. General

1. Provide off-site borrow soil materials meeting the requirements of these Specifications when sufficient satisfactory soil materials are not available from onsite sources.

2. Fill, backfill, and embankment materials shall be selected or shall be processed and shall consist of clean fine earth, rock, gravel, or sand, free from debris, waste, frozen materials, grass, roots, brush, other vegetation and organic matter.

3. Fill and backfill materials that are to be placed within 6 inches of any structure or pipe shall be free of rocks or unbroken masses of earth materials having a maximum dimension larger than 3 inches.

B. Suitable Fill and Backfill Materials

1. Satisfactory fill and backfill soils shall be classified as GW, GP, GM, GC, SW, SP, SM, and SC according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 6 inches in any dimension, debris, waste, frozen material, vegetation and organic matter, and other deleterious matter.

2. Unsatisfactory fill and backfill soils include MH, CH, OL, OH, and PT according to ASTM D 2487, or a combination of these groups. Unsatisfactory backfill soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at the time of compaction.

3. If acceptable to the Engineer, some of the materials listed as unsuitable may be used when thoroughly mixed with suitable material to form a stable composite.

4. Mixing or blending of materials to obtain a suitable composite is the Contractor's option but is subject to the approval of the Engineer.

5. Suitable materials may be obtained from on-site excavations, may be processed on-site materials, or may be imported.

6. If imported materials are required by this Section or are required in order to meet the quantity requirements of the Work, the Contractor shall provide the imported materials as part of the Work.

2.2 STRUCTURAL FILL

A. Structural fill shall be free of organic matter or other unsuitable materials.

B. Imported granular structural fill shall be pit or quarry run rock, crushed rock, or crushed gravel and sand and meet the following requirements for grading and quality

Sieve Size	Percent Passing
4”	99-100
2”	75-100
No. 4	50-80
No. 40	30 max
No. 200	7.0 max
Sand Equivalent	50 min

2.3 RIP RAP AND QUARRY SPALLS

A. Rip rap and quarry spalls shall consist of broken stone or broken concrete rubble and shall be free of rock fines, soils, or other extraneous materials. Concrete rubble shall not be contaminated by foreign materials such as fibers, wood, steel, asphalt, sealant, soil, plastic and other contaminants or deleterious material. Rip rap and quarry spalls shall be free from segregation, seams, cracks, and other defects tending to destroy its resistance to weather.

B. Rip rap shall meet the following requirements for grading:

	Size Range	Maximum Size
20% to 90%	300 lbs to 1 ton (2 cu ft to 1/2 cu yd)	N/A
15% to 80%	50 lbs to 1 ton (½ cu ft to 1/2 cu yd)	300 lbs to 1 ton (2 cu ft to 1/2 cu yd)
10% to 20%	3 inch	50 lbs (spalls)

C. Quarry spalls shall meet the following requirements for grading:

Sieve Size	Percent Passing
8”	100
3”	40 max
3/4"	10 max

2.4 GRAVEL SURFACE

A. Crushed surfacing shall be manufactured from ledge rock, talus, or gravel. The materials shall be free from wood, roots, bark, and other extraneous materials and shall meet the following quality test requirements:

1. Los Angeles Wear, 500 Rev: 35 percent max

2. Degradation Factor – Top Course: 25 min

3. Degradation Factor – Base Course: 15 min

B. Crushed surfacing of the various classes shall meet the following requirements for grading and quality when placed in hauling vehicles for delivery to the roadway, or during manufacture and placement into temporary stockpile. The exact point of acceptance shall be determined by the Engineer.

C. Crushed surfacing shall meet the following gradation requirements:

Sieve Size	Base Course	Top Course and Keystone
	Percent Passing	
1-1/4”	99-100	
1”	80-100	
3/4"		99-100
5/8”	50-80	
1/2"		80-100
No 4	24-45	46-66
No 40	3-18	8-24
No 200	7.5 max	10 max
% Fracture	75 min	75 min
Sand Equivalent	40 min	40 min

D. The fracture requirement shall be at least one fractured face and will apply to the combined aggregate retained on the No 4 sieve.

E. The portion of crushed surfacing retained on a No 4 sieve shall not contain more than 0.15 wood waste.

2.5 MATERIALS TESTING

A. Samples

The Engineer may direct the Contractor to supply samples for testing of any material used in the Work.

B. Particle size analysis of soils and aggregates will be performed using ASTM D 6913 - Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.

C. Atterberg Limits testing of soil will be performed using ASTM D 4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

D. Determination of sand equivalent value will be performed using ASTM D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.

E. Unified Soil Classification System

1. References in this Section to soil classification types and standards shall have the meanings and definitions indicated in ASTM D 2487.

2. The Contractor shall be bound by applicable provisions of ASTM D 2487 in the interpretation of soil classifications.

F. Moisture-density curves for each type of material from each source of material to be compacted to a specified density shall be performed in accordance with ASTM D698.

G. Sieve analysis for all granular material shall be performed in accordance ASTM C136

H. Testing for sulfate, resistivity, and pH shall be performed in accordance with ASTM D512, ASTM C1590-09, ASTM D4972, and ASTM G57.

I. Testing for chloride shall be performed in accordance with AASHTO T291-94 – Standard Method of Test for determining Water-Soluble Chloride Ion Content in Soil.

PART 3 -- EXECUTION

3.1 EXCAVATION AND BACKFILLING - GENERAL

A. General

1. Except when specifically provided to the contrary, excavation shall include the removal of materials, including obstructions, that would interfere with the proper execution and completion of the Work.

2. The removal of such materials shall conform to the lines and grades indicated or ordered.

3. Unless otherwise indicated, the entire Site shall be stripped of vegetation and debris and shall be grubbed, and such material shall be removed from the Site or stockpiled in areas identified on the plans prior to performing any excavation or placing any fill.

4. The Contractor shall furnish, place, and maintain supports and shoring that may be required for the sides of excavations.

5. Excavations shall be sloped or otherwise supported in a safe manner in accordance with applicable Washington safety requirements, the requirements of OSHA Safety and Health Standards for Construction (29CFR1926), and the project Geotechnical Report. Temporary excavations shall not be sloped steeper than 1H:1V without a support system.

6. Excavation and backfilling shall be performed in a manner and sequence that will provide proper drainage at all times.

7. The Contractor shall provide quantity surveys where required to verify quantities for Unit Price Contracts.

8. Where required, surveys shall be performed prior to beginning Work and upon completion by a surveyor licensed in the Washington where the Site is located.

3.2 OVER-EXCAVATION

A. Indicated

1. Where areas are indicated to be over-excavated, excavation shall be to the depth indicated, and backfill shall be placed to the grade indicated.

B. Ordered

1. When ordered to over-excavate areas deeper and/or wider than required by the Contract Documents, the Contractor shall over-excavate to the dimensions ordered and backfill to the indicated grade.

C. Neither Indicated nor Ordered

1. Any over-excavation carried below the grade that is neither ordered nor indicated shall be backfilled and compacted to the required grade with the indicated material as part of the Work.

3.3 EXCAVATION IN LAWN AREAS

A. Where excavation occurs in lawn areas, the sod shall be carefully removed, dampened, and stockpiled in order to preserve it for replacement.

B. Excavated material may be placed on the lawn, provided that a drop cloth or other suitable method is employed to protect the lawn from damage, but the lawn shall not remain covered for more than 72 hours.

C. Immediately after completion of backfilling and testing of the pipelines, the sod shall be replaced and lightly rolled in a manner as to restore the lawn as near as possible to its original condition.

D. The Contractor shall provide new sod if the stockpiled sod has not been replaced within 72 hours.

3.4 EXCAVATION IN VICINITY OF TREES

A. Except where trees are indicated to be removed, trees shall be protected from damage during construction operations.

B. No tree roots larger than 2 inches in diameter shall be cut without the express permission of the Engineer.

C. Trees shall be supported during excavation by any means previously reviewed and accepted by the Engineer.

3.5 COLD WEATHER

A. In cold weather, protect excavated surfaces against which fill materials will be placed from freezing by sequencing stripping to minimize the exposed area, by using a temporary layer of soil or insulating materials, or other means authorized by the Engineer. Remove protection only when the Contractor is ready to place fill.

B. In cold weather, excavated foundation surfaces against which structures or pipes will be placed will be protected from freezing. Use a temporary layer of soil, insulating materials, heating and hoarding, or other means authorized by the Engineer. Remove protection only when the Contractor is ready to install the structure or to place fill.

C. In cold weather, protect borrow area materials from freezing by sequencing Topsoil stripping to minimize the exposed areas and by placing a temporary layer of soil on exposed areas. Remove protection only when the Contractor is ready to place materials excavated from borrow areas.

3.6 ROCK EXCAVATION

A. Rock excavation shall include removal and disposal of the following items:

1. Single boulders, pieces of concrete or masonry with a volume in excess of 1/3 yd^3 or any material that cannot be removed by a tracked machine, having a bucket capacity of 1.25 to 1.5 yd^3 and which requires for its removal, drilling and blasting or breaking up with a power operated hand tool.

2. Rock material in ledges, bedding deposits, un-stratified masses, and conglomerate deposits that cannot be removed using a tracked machine, having a bucket capacity of 1.25 to 1.5 yd^3 and which requires for its removal, drilling and blasting or breaking up with a power operated hand tool.

B. Explosives and Blasting

1. Blasting will not be permitted

3.7 DISPOSAL OF EXCESS EXCAVATED MATERIAL

A. Unless otherwise indicated, excess excavated material shall be the property of the Contractor.

B. The Contractor shall be responsible for the removal and disposal of excess excavated material.

C. Material shall be disposed of at an approved on-Site disposal area or off-Site at a location arranged by the Contractor in accordance with the Contract, and laws and regulations regarding the disposal of such material.

3.8 BACKFILL

A. General

1. Backfill shall not be dropped directly upon any structure or pipe.

2. Backfill shall not be placed around or upon any structure until the concrete has attained sufficient strength to withstand the loads imposed.

3. Backfill around water-retaining structures shall not be placed until the structures have been tested, and the structures shall be full of water while backfill is being placed.

B. Except for free-draining rock materials being placed in over-excavated areas or trenches, backfill shall be placed after water is removed from the excavation and the trench sidewalls and bottom have been dried to a moisture content suitable for compaction.

C. Pre-Placement Conditions

1. Immediately prior to placement of backfill materials, the bottoms and sidewalls of trenches and structure excavations shall have any loose, sloughing, or caving soil and rock materials removed.

D. Layering

1. Backfill materials shall be placed and spread evenly in layers.

2. When compaction is achieved using mechanical equipment, the layers shall be evenly spread such that each layer shall not exceed 8 inches in loose thickness, or 5 inches in loose thickness when using hand-operated compaction equipment.

E. During spreading, each layer shall be thoroughly mixed as necessary in order to promote uniformity of material in each layer.

F. Moisture Content

1. Where the fill material moisture content is below the optimum moisture content limit as determined by ASTM D1557, the Contractor shall add water before or during spreading until the proper moisture content is achieved.

2. Where the fill material moisture content is above the optimum moisture content limit as determined by ASTM D1557, the material shall be dried until the moisture content is satisfactory.

3.9 STRUCTURE, ROADWAY, AND EMBANKMENT EXCAVATION AND BACKFILL

It is suggested that Project cross sections be prepared to show the desired extent of excavations and the materials to be placed beneath and around structures. Consult with the Project Geotechnical Engineer. Project cross sections must be consistent with the recommendations of the Project Geotechnical Engineer and the provisions herein.

A. Excavation Beneath Structures and Embankments

1. Except where indicated otherwise for a particular structure or where ordered by the Engineer, excavation shall be carried to an elevation 6 inches below the bottom of the footing or slab and brought back to grade with compacted materials acceptable for placement beneath structures.

2. The area where a fill or embankment is to be constructed shall be cleared of vegetation, roots, and foreign material.

3. Where indicated or ordered, areas beneath structures or fills shall be over-excavated.

4. The subgrade areas beneath embankments shall be excavated to remove not less than the top 6 inches of native material and where such subgrade is sloped, the native material shall be benched.

5. When such over-excavation is indicated, both the over-excavation and the subsequent backfill to the required grade shall be performed by the Contractor.

6. After the required excavation or over-excavation for fills and embankments has been completed, the exposed surface shall be scarified to a depth of 6 inches brought to optimum moisture content, and rolled with heavy compaction equipment to obtain the maximum dry density as detailed in this Specification Section.

B. Excavation Beneath Concrete Reservoirs

1. Excavation under reservoirs shall extend to the bottom of the drain rock layer.

2. After such excavation has been completed, the exposed surface shall be rolled with heavy compaction equipment to obtain the maximum dry density as detailed in this Section, and then graded to provide a reasonably smooth surface for placement of the drain rock.

3. Areas under the reservoir upon which fill, not drain rock, is to be placed, shall be scarified to a depth of 6 inches, brought to optimum moisture content, and compacted to obtain the maximum dry density as detailed in this Specification Section.

C. Excavation Beneath Paved Areas

1. Excavation under areas to be paved shall extend to the bottom of the aggregate base or subbase, if such base is called for; otherwise it shall extend to the paving thickness.

2. After the required excavation has been completed, the top 12 inches of exposed surface shall be scarified, brought to optimum moisture content, and rolled with heavy compaction equipment to obtain the maximum dry density as detailed in this Specification Section.

3. The finished subgrade shall be even, self-draining, and in conformance with the slope of the finished pavement.

4. Areas that could accumulate standing water shall be regraded to provide a self-draining subgrade.

D. Notification of Engineer

1. The Contractor shall notify the Engineer at least 3 Days in advance of completion of any structure or roadway excavation and shall allow the Engineer a review period of at least one day before the exposed foundation is scarified and compacted or is covered with backfill or with any construction materials.

E. Compaction of Fill, Backfill, and Embankment Materials

1. Each layer of backfill material as defined herein, where the material is graded such that 10 percent or more passes a No. 200 sieve, shall be mechanically compacted to at least the indicated percentage of maximum dry density (as determined by ASTM D1557).

2. Equipment that is consistently capable of achieving the required degree of compaction shall be used, and each layer shall be compacted over its entire area while the material is at the required moisture content.

3. Each layer of coarse granular backfill materials with less than 10 percent passing the No. 200 sieve shall be compacted by means of at least 2 passes from a vibratory compactor that is capable of obtaining the required density in 2 passes.

F. Roofs

1. Fill on reservoir and structure roofs shall be deposited not sooner than 30 Days after the concrete roof slab has been placed.

2. Equipment weighing more than 10,000 lbs when loaded shall not be used on a roof.

3. A roller weighing not more than 8,000 lbs shall be used to compact fill on a roof.

G. Flooding, ponding, and jetting shall not be used for fill on roofs, backfill around structures, backfill around reservoir walls, for final backfill materials, or aggregate base materials.

H. Heavy Equipment

1. Equipment weighing more than 10,000 lbs shall not be used closer to walls than a horizontal distance equal to the vertical depth of the fill above undisturbed soil at that time.

2. Hand-operated power compaction equipment shall be used where the use of heavier equipment is impractical or restricted due to weight limitations.

I. Layering

1. Embankment and fill material shall be placed and spread evenly in approximately horizontal layers.

2. Each layer shall be moistened and aerated as necessary to obtain a moisture content within range of –2 to + 2 percent of optimum moisture content at the time of compaction.

3. Unless otherwise approved by the Engineer, no layer shall exceed 8 inches of loose thickness.

4. The embankment and fill shall be compacted in conformance with Paragraph K, below.

J. Embankments and Fills

1. When an embankment or fill is to be constructed and compacted against hillsides or fill slopes steeper than 4:1, the slopes of the hillsides or fills shall be horizontally benched in order to key the embankment or fill to the underlying ground.

2. A minimum of 12 inches perpendicular to the slope of the hillside or fill shall be removed and re-compacted as the embankment or fill is brought up in layers.

3. Material thus cut shall be re-compacted along with the new material.

K. Compaction Requirements

1. The following compaction requirements shall be in accordance with ASTM D 1557 - Test Method for Laboratory Compaction Characteristics of Soils Using Modified Effort 56,000 ft - lbf/ft^3 where the material is graded such that 10 percent or more passes a No. 200 sieve and in accordance with ASTM D 4253 - Test Method for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table, and D 4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, where the material is coarse granular backfill materials with less than 10 percent passing the No. 200 sieve:

Location or Use of Fill or Backfill	**Percentage of Maximum Dry Density**	**Percentage of Relative Density**
Embankments and fills not identified otherwise	90	55
Embankments and fills beneath paved areas or structures	95	70
Backfill beneath structures and hydraulic structures	95	70
Backfill on reservoir of structure roof	90	55

Topsoil	80	NA
Aggregate base or subbase	95	NA

3.10 FIELD TESTING

A. General:

1. Field soils testing will be performed as indicated elsewhere in this Specification.

B. Density

1. Where soil material is required to be compacted to a percentage of maximum density, the maximum dry density and optimum moisture content will be determined in accordance with Method C of ASTM D 1557.

2. Where cohesionless, free draining soil material is required to be compacted to a percentage of relative density, the calculation of relative density will be determined in accordance with ASTM D 4253 and D 4254.

3. Field density in-place tests will be performed in accordance with ASTM D 1556/D 1556M - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method, ASTM D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate in Place By Nuclear Methods (Shallow Depth), or by such other means acceptable to the Engineer.

C. Testing Frequencies

1. Pit-run gravel - one for each 2000 yd^2 of compacted layers.

2. Crushed gravel - one for each 2000 yd^2 of compacted layers.

3. Imported and/or excavated fill placement – two tests for each fill layer installed for areas less than 500 square feet and one additional test for every additional 500 square feet.

D. Remediation

1. In case the test of the fill or backfill shows non-compliance with the required density, the Contractor shall accomplish such remedy as may be required to ensure compliance.

2. Subsequent testing to show compliance shall be by a testing laboratory selected by the Owner and paid by the Contractor.

END OF SECTION

SECTION 31 63 33 – DRILLED MICROPILES

PART 1 -- GENERAL

1.01 SUMMARY

A. Install a micropile system that will develop the load capacities indicated on the Contract Drawings. The micropile load capacities and measurements shall be verified by testing as specified herein.

B. Furnish all necessary engineering and construction services, supervision, labor, materials, and equipment to perform all work necessary to install and test the micropiles in accordance with the contract documents. Engineering for any proposed design alternatives to be provided by the Contractor.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 33 00	Submittal Procedures
03 30 50	Cast-in-Place Concrete

B. Definitions

1. Admixture: Substance added to the grout to either control bleed and/or shrinkage, improve flowability, reduce water content, retard setting time, or resist washout.

2. Alignment Load (AL): A minimum load applied to a test pile during testing to keep the testing equipment correctly positioned.

3. Apparent Free Micropile Length: The length of pile, which is apparently not bonded to the surrounding ground, as calculated from the elastic load extension data during testing.

4. Bond Breaker: A sleeve or coating placed over the steel reinforcement to prevent load transfer.

5. Bond Length: The length of the micropile that is bonded to the ground and which is conceptually used to transfer the applied axial loads to the surrounding soil or rock.

6. Casing: Steel pipe introduced during the drilling process to stabilize the drill hole. Where indicated, the casing shall remain completely in place as part of the final pile configuration.

7. Centralizer: A device to centrally locate the reinforcing element(s) within the borehole.

8. Core Steel: Reinforcing bars or pipes used to strengthen or stiffen the pile, excluding any left-in drill casing.

9. Corrosion Inhibiting Compound: Material used to protect against corrosion (and/or lubricate the reinforcing steel inside a bond breaker).

10. Coupler: The means by which the load can be transmitted from one partial length of reinforcement to another.

11. Creep Movement: The movement that occurs during the creep test of a micropile under a constant load.

12. Duplex Drilling: A drilling system involving the simultaneous advancement of (inner) drill rod and (outer) drill casing. Flush from the inner drill rod is permitted to exit the borehole via the annulus between rod and casing.

13. Elastic Movement: The recoverable movement measured during a micropile test.

14. Encapsulation: A corrugated tube protecting the reinforcing steel against corrosion.

15. Engineer: Structural Engineer of Record as appropriate.

16. Free (unbonded) length: The designed length of the micropile that is not bonded to the surrounding ground or grout during testing.

17. Micropile: A 12 inch or smaller diameter, drilled and grouted cast-in-place composite pile, in which the applied load is resisted by steel reinforcing elements, grout, and frictional ground-grout bond. Note that the terms “micropile” and “pile” are used interchangeably throughout this specification.

18. Overburden: Non-lithified material, natural or placed, which normally requires cased drilling methods to provide an open borehole to underlying strata.

19. Performance Test: Incremental loading and unloading over several cycles, recording total movement at each increment.

20. Pile: See “Micropile”.

21. Post Grouting: The injection of additional grout into the bond length of a micropile after the primary grout has set. Also known as regrouting or secondary grouting.

22. Preloading: The principle whereby load is applied to the micropile, prior to the micropile's connection to the structure, to minimize any structural movement in service.

23. Primary Grout: Portland cement-based grout that is injected into the micropile hole prior to or after the installation of the reinforcement to provide the load transfer to the surrounding ground along the micropile and affords a degree of corrosion protection in compression.

24. Production pile: A micropile constructed as part of the final structure.

25. Proof Load Test: Incremental load testing of a production micropile as indicated herein.

26. Reinforcing steel: The steel element used to strengthen or stiffen a micropile.

27. Residual Movement: The non-elastic (non-recoverable) movement of a micropile measured during load testing.

28. Safety Factor: The ratio of the ultimate or tested capacity to the service load used for the design of any component or interface.

29. Service Load (SL): Anticipated final maximum allowable service load in the micropile.

30. Single Tube Drilling: The advancement of a steel casing through overburden usually aided by water flushing through the casing, also known as "external flush." The fluid may or may not return to the surface around the casing, depending largely on the permeability of the overburden.

31. Steel Reinforcing Element: Steel element used to strengthen or stiffen a micropile, such as bar reinforcing steel, high-strength threaded bar, pipe, or hollow structural section (HSS)

32. Test Load (TL): The maximum load to which the micropile is subjected during testing.

33. Test Pile: Micropile used for load testing.

34. Tremie Grouting: The placing of grout in a borehole via a grout pipe introduced to the bottom of the hole. During grouting, the exit of the pipe is kept at least 10 feet below the level of the grout in the hole.

35. Type A-D: Classification of micropiles based on method and pressure of grouting as indicated in FHWA-NHI-05-039.

36. Verification Load Test: Incremental load testing of a verification micropile as indicated herein.

37. Verification Pile: a micropile constructed to verify that the design and construction of the micropiles attain the specified micropile capacities, including the required safety factor.

38. Working Load: Equivalent term for Service Load.

C. Reference Standards

1. The edition of the standards applicable to the Work shall be those editions referenced by the 2021 International Building Code (IBC). If the standard is not referenced by the IBC, nor an IBC-referenced standard listed below, the edition of the standard applicable to the Work shall be the edition in effect on the date of signing and sealing of the contract specifications.

American Concrete Institute (ACI)	
ACI 318	Building Code Requirements for Structural Concrete
American Petroleum Institute (API)	
API 5CT (N80)	Specification for Casing and Tubing
API 13B-1	Recommended Practice for Field Testing Water-based Drilling Fluids
ASTM International (ASTM)	
ASTM A36	Specification for Carbon Structural Steel

ASTM A252	Specification for Welded and Seamless Steel Pipe Piles
ASTM A572	Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A722	Specification for High-Strength Steel Bars for Prestressed Concrete
ASTM A 775	Epoxy - Coated Reinforcing Steel Bars
ASTM A1064	Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C33	Specification for Concrete Aggregates
ASTM C109	Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
ASTM C144	Specification for Aggregates for Masonry Mortar
ASTM C150	Specification for Portland Cement
ASTM C188	Test Method for Density of Hydraulic Cement
ASTM C494	Specification for Chemical Admixtures for Concrete
ASTM D1143	Test Methods for Deep Foundations Under Static Axial Compressive Load
ASTM D1784	Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM D3689	Test Methods for Deep Foundations Under Static Axial Tensile Load
ASTM F3125	Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength
American Society of Civil Engineers (ASCE)	
ASCE 20-96	Standard Guidelines for the Design and Installation of Pile Foundations
American Welding Society (AWS)	
AWS D1.1	Structural Welding Code – Steel
AWS D1.4	Structural Welding Code – Reinforcing Steel
Federal Highway Administration (FHWA)	
FHWA-NHI-05-039	U.S. Department of Transportation, Federal Highway Administration (FHWA), “Micropile Design and Construction”, Report No. FHWA-NHI-05-039, December 2005
International Code Council (ICC)	
IBC	2021 International Building Code
Post Tensioning Institute (PTI)	

PTI	POST-TENSIONING INSTITUTES STANDARDS (PTI) "Guide Specification for Post-Tensioning Materials and Rock and Soil Anchors" Post-Tensioning Manual, 5th Edition

1.03 PRE-INSTALLATION MEETING

A. A mandatory pre-installation meeting shall be scheduled by the Contractor at least 7 days after review and acceptance of the micropile experience qualifications, shop drawings, and installation plan by the Engineer, and at least 14 days prior to the start of micropile construction.

B. The Owner, Contractor, Engineer, Inspector and Independent Testing Agency shall attend.

C. The pre-installation meeting shall be held to clarify the structural, geotechnical, and construction requirements, materials and load testing protocols, and to coordinate and schedule activities.

1.04 CONTRACTOR SUBMITTALS

A. General

1. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

2. Do not order materials nor install micropiles until the experience qualifications, shop drawings, and installation plan are approved.

3. Submit all items indicated herein.

B. Experience Qualifications

1. A summary of the micropile Subcontractor's experience that demonstrates compliance with Section 1.5 – Quality Assurance.

2. Resumés for the micropile Subcontractor's superintendent/foreman, drill rig operator(s), and project manager. The resumés shall include a summary of each individual's experience that demonstrates compliance with Section 1.5 – Quality Assurance.

3. Construction details and load test results from at least 3 completed micropile installations performed by the micropile Subcontractor in the last 5 years. The installations shall be from 3 separate projects of similar scope to this Contract. Include a project description and the owner's name and current phone number for each project.

C. Shop Drawings

1. General notes for constructing the micropiles, including:

a. Overall construction sequencing.

b. A detailed description of the construction procedures proposed for use.

c. A schedule of major equipment resources.

2. Materials and material properties for all micropile components.

3. Plan view drawings showing:

    a. Unique identification number for each micropile.

    b. Micropile location and spacing.

    c. Micropile cut-off elevation(s)

    d. Micropile tip elevation(s)

    e. Micropile design load.

    f. Micropile test load.

4. Section view drawings showing:

    a. Micropile inclination

    b. Drilled hole diameter.

    c. Cased length, plunge length and bond length.

    d. Micropile anchorage and bearing plate details.

    e. Steel reinforcing details, including reinforcing bar lengths, diameter(s), splice locations and coupler details.

    f. Permanent casing details, including casing length, diameter, thickness, splice locations and details.

    g. Temporary casing details, including casing length, diameter, thickness, splice locations and details.

    h. Corrosion protection details.

    i. Centralizer locations.

    j. Grouting volumes and maximum pressures.

    k. Level of each stage of grouting.

D. Installation Plan

1. Detailed construction procedures, including personnel, testing, and equipment.

2. Layout drawing showing the micropile installation sequence.

3. Information on headroom and space requirements for installation equipment that verifies that the equipment can perform at the job site.

4. Drilling or coring methods and equipment, including methods to:

    a. Provide drilled hole support.

    b. Drill a straight and properly aligned hole.

c. Advance through boulders and other obstructions.

d. Prevent detrimental ground movements.

5. Methods for placing, positioning, and supporting steel reinforcing elements.

6. Grouting plan, including:

a. Procedures for monitoring grout quality.

b. Placement procedures and equipment, including details for post-grouting, if applicable.

c. Methods and equipment for monitoring and recording grout depth, volume, and pressure as the grout is placed.

d. Grouting rate calculations. Base the calculations on the initial pump pressures or static head on the grout and losses throughout the placing system, including anticipated head of drilling fluid to be displaced, if applicable.

e. Minimum cure time and strength requirements for performing load testing.

f. Plan for the control and disposal of surface and groundwater, drill flush, and waste grout.

7. Load Testing Plan, including drawings and calculations that describe

a. Testing procedures.

b. Reaction load system design, capacity and equipment set-up.

1) Reaction load system calculations and drawings shall be signed and sealed by a Professional Engineer registered in the State of Washington.

c. Types and accuracy of the primary and secondary instrumentation equipment to be used for applying and measuring the test loads and measuring the top of micropile movements.

d. Installation details for the instrumentation to be used for applying and measuring the test loads and measuring the top of micropile movements.

8. Calibration reports and data for each test jack, pressure gauge, load cell, and electronic displacement transducer to be used. The load cell calibration chart must show applied load versus millivolts per volt.

a. The calibration tests shall have been performed by an independent testing laboratory and tests shall have been performed within 45 days of the date submitted.

E. Mill Test Reports

1. Certified mill test reports, properly marked, for the reinforcing steel and casing, as the materials are delivered, to the Engineer for record purposes.

a. The ultimate strength, yield strength, elongation, and chemical composition shall be included.

b. For steel pipe used as permanent casing or core steel, the Contractor shall submit a minimum of two representative coupon tests or mill certifications on each load delivered to the project.

F. Weld Procedures

1. Welding procedures for casing welds.

G. Grout Mix Designs

1. Grout mix designs.

2. Test results from an authorized laboratory for the compressive strength of the mix at 3, 7, 14, and 28 days.

3. Grout mix efflux time.

4. Grout mix density.

H. Installation Logs

1. Installation logs shall be completed and submitted within 24 hours after each pile installation is completed. The logs shall include the following minimum information:

a. Micropile identification number and location.

b. Names of drill rig operator, superintendent, grout plant operator, and all other personnel involved with the installation of the micropile.

c. Date, time, and duration of drilling, casing and reinforcing steel installation, and grout placement.

d. Drilling or coring method and speed.

e. Description of soil and rock encountered, including description of strata, water, etc.

f. Quantity of groundwater encountered.

g. Drilled hole diameter.

h. Micropile tip elevation.

i. Micropile cut-off elevation.

j. Log of grout quantities and pressures, including the time and micropile depth.

k. Lengths of casing and reinforcing steel elements.

l. Details of splicing operations, including location of splices or joints.

m. Description of any unusual installation behaviors or conditions.

n. Any deviations from the intended parameters.

I. Grout Test Results

1. Submit grout test results for density, efflux time, and compressive strength within 1 business day of testing.

J. Load Test Data

1. Submit load test data within 1 business day of the completion of a verification or proof load test.

2. Load test data shall include:

a. Micropile identification number and location.

b. Installation date.

c. Load test date.

d. Testing personnel.

e. Load testing equipment.

f. Raw data from the electronic data acquisition system.

g. Readings from the secondary load and displacement measurement systems recorded at each load increment.

h. Specified curves plotted using data from the electronic data acquisition system.

i. Comparison of the load test results and the acceptance criteria.

3. Load test data shall be signed and sealed by a Professional Engineer registered in the State of California.

K. As-built drawings

1. Submit as-built drawings showing the location of the micropiles, their depth and inclination, sequence of placement, and details of their composition within 14 calendar days of completion of installation of each of the foundation construction phases as indicated below. Include the location of verification test piles and production piles, including any piles that are abandoned. Clearly indicate which piles were verification test piles and proof test piles.

2. Construction of the foundation slabs shall not begin prior to the Engineer's review and approval of the as-built drawings.

1.05 QUALITY ASSURANCE

A. Contractor's Qualifications:

1. The Contractor shall have a minimum of five (5) years of verifiable experience with the successful construction, testing, and installation of micropile systems of similar scope and size.

2. The Contractor shall only use personnel who are thoroughly trained and familiar with the equipment and procedures used in the application of the specified materials.

3. The superintendent/foreman, drill rig operator, and project manager shall be present on site, shall be materially involved, and shall each have at least three years of relevant experience.

4. The Contractor shall have previous micropile drilling and grouting experience in soil or rock similar to the soil or rock for this Contract.

B. The Owner will retain the services of an Independent Testing Agency to observe and verify the proper execution and recording of the verification load testing and proof load testing of the micropiles as described in this section. The Independent Testing Agency shall have at least 5 years of experience with micropile testing.

1.06 QUALITY CONTROL

A. Grout Testing

1. The Contractor shall test grout as indicated herein.

2. Before placing grout into each micropile:

a. Test the grout density under API RP 13B-1 using the Baroid mud balance. Take the grout test samples directly from the grout plant.

b. Test the grout efflux time under California Test 541. Take the grout test samples at the point of placement.

B. Test the grout compressive strength in accordance with ASTM C109 at an authorized laboratory. Take at least 1 set of three 2-inch grout cubes from each grout plant each day of operation or for every 10 micropiles installed, whichever occurs more frequently. Take the grout test samples directly from the grout plant.

1.07 SITE CONDITIONS

A. The project's Geotechnical Data Report is included with the Contract Documents. The Owner does not assume any responsibility for the Contractor's interpretation of data contained in this report.

B. If, during the installation of a pile, an obstruction is encountered that prevents the practical advancement of the hole, the hole shall be abandoned and filled with grout. A new pile shall be drilled at a location to be determined by the Engineer, although it shall be acknowledged that in certain instances, relocation options may be severely limited, and further attempts at the original location with different methods may be required.

1.08 GEOTECHNICAL ENGINEER

1. A Geotechnical Engineer selected and paid by the Owner shall observe work as indicated herein to be executed under this section. The Geotechnical Engineer shall always have access to the work and data and be furnished every reasonable help for checking the progress and coordination of all phases of work. Advice to the Contractor by the Geotechnical Engineer, either solicited or freely given, shall not diminish the Contractor's responsibility to install permanent micropiles according to these specifications.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Furnish materials new and without defects. Remove defective materials from the jobsite at no additional cost.

2.02 MICROPILE SYSTEM

A. Micropiles shall be Type B according to FWHA-NHI-05-039, unless approved otherwise by the Engineer, with a permanent casing as indicated on the Contract Drawings, cement grout as specified placed under gravity or pressure full height, and with a single reinforcing bar centered along the pile length. The micropile locations, depths, and sizes installed shall conform to the Contract Drawings.

2.03 MATERIALS

A. General

1. Materials and element sizes used for verification test micropiles shall be identical to those used for the associated production piles.

B. Water

1. Water for mixing grout shall be potable, clean, and free from any substance which may be deleterious to grout or steel.

C. Admixtures

1. Admixtures shall conform to the requirements of Section 03 30 00 – Cast-in-Place Concrete and ASTM C494.

2. Admixtures which control bleed, improve flowability, reduce water content, and retard set may be used in the grout subject to the review and acceptance of the Engineer and shall be the product of one manufacturer.

3. Expansive admixtures shall only be added to the grout used for filling sealed encapsulations.

4. Accelerators shall not be used.

5. Admixtures with chlorides shall not be used.

6. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations. Their use will only be permitted after appropriate field tests on fluid and set grout properties.

D. Cement

1. Cement shall conform to the requirements of Section 03 30 00 – Cast-in-Place Concrete.

2. All cement shall be Portland cement conforming to ASTM C150 Type II or Type V and shall be the product of one manufacturer. If the brand or type of cement is changed during a project, additional grout mix tests shall be conducted to ensure consistency of quality and performance in situ.

E. Grout

1. Grout shall be a stable, neat grout consisting of cement and water.

2. Grout shall have a minimum 28-day compressive strength of 4,000 psi.

3. Efflux time shall be at least 11 seconds.

4. Density shall be greater than or equal to the density submitted with the authorized mix design.

F. Reinforcing Steel

1. Reinforcing steel shall conform to ASTM A722 Grade 75 Reinforcing steel shall be continuously threaded bars specifically manufactured for the purpose of ground anchors; Dywidag Threadbar Anchor by DSI, 150 KSI All-Thread Bar by Williams, or equal.

2. When a bearing plate and nut are required to be threaded onto the top end of reinforcing steel for the pile top to footing anchorage, the threading shall be continuous spiral deformed ribbing provided by the bar deformations. Anchor nut shall be per the reinforcing steel manufacturer's recommendations and shall develop the ultimate tensile strength of the threaded bar.

3. Bar tendon couplers shall develop the ultimate tensile strength of the bars without evidence of any failure.

4. Reinforcing steel, nuts, couplers and all other appurtenances associated with the manufactured reinforcing steel shall be manufactured and provided by the same manufacturer.

5. Reinforcing steel and couplers shall be epoxy coated in accordance with ASTM A775, except that the bend test requirements are waived.

   a. Epoxy coating thickness shall be 10 to 12 mils.

   b. Epoxy coating shall be continuous from the bottom of the reinforcing steel and shall extend at least 5 feet into the permanent casing.

   c. Nicks, chips or other damage to the epoxy coating shall be repaired in accordance with the epoxy coating manufacturer's recommendations, using materials specifically manufactured for repairing epoxy coatings.

G. Casing/Pipe

1. The permanent steel casing/pipe shall meet the requirements for API N80 Quench and Tempered pipe and the tensile requirements of ASTM A252, Grade 3, except that the minimum yield strength shall be 80,000 psi, the minimum tensile strength shall be 100,000 psi, and the minimum elongation under load shall be 15 percent.

2. For API N80 pipe casing, coupon test results may be submitted in lieu of mill certification.

3. Where casing consists of multiple sections, the sections shall be connected by threaded or welded connections. The connections shall develop the ultimate tensile strength of the casing sections. Welded splices shall be complete joint penetration welds.

H. Bearing Plates

1. The bearing plates shall be ASTM A572 Grade 50 steel.

I. Centralizers

1. Centralizers shall be fabricated from a material, other than wood, that is not deleterious to the reinforcing steel and the corrosion protection. The centralizers shall be of sufficient strength to support the weight of the bar reinforcement in the drilled hole and provide a minimum of 2” of grout cover. The centralizers shall not impede the flow of grout and shall allow extending the grout tremie pipe to the bottom of the drill hole.

PART 3 -- EXECUTION

3.01 GENERAL

A. Do not construct any production piles until the associated verification test results have been reviewed and approved by the Engineer.

B. Do not drill, pressure grout, or post-grout a micropile that is within a center-to-center spacing of 5 feet from an open micropile or a micropile in which the initial grout has set for less than 12 hours.

C. The Contractor shall verify dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of Work. The Contractor shall review the Drawings, and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

D. The micropile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the project. The Contractor shall select the drilling method and the grouting procedures used for the installation of the micropiles, subject to the approval of the Engineer.

E. All installation techniques shall be determined and scheduled such that there will be no interconnection or damage to piles in which grout has not achieved final set.

F. The Contractor shall check pile top elevations and adjust all installed micropiles to the planned elevations.

G. Micropiles constructed for the purpose of verification testing shall be constructed in the presence of the Engineer.

3.02 DRILLING

A. The drilling equipment and methods shall be suitable for drilling through the conditions to be encountered, with minimal disturbance to these conditions or any overlying or adjacent structure or service.

B. Use temporary casing or another authorized drilled hole support method in caving or unstable ground. Temporary casing shall not be left in place.

C. Permanent casing shall be installed as indicated on the Contract Drawings. Splice casing in a manner that ensures the longitudinal axes of the 2 spliced lengths are aligned.

D. Use of vibratory pile-driving hammers to advance casing shall not be permitted.

E. Remove any material dislodged or drawn into the hole during micropile construction. The borehole shall be open to the defined nominal diameter, full length, prior to placing grout or any steel reinforcing elements not used to case the drilled hole.

F. After drilling, the hole shall be flushed with water and/or air to remove drill cuttings

3.03 AND/OR OTHER LOOSE DEBRIS.PLACING AND SPLICING REINFORCING STEEL

A. Install reinforcing steel before withdrawing any temporary casing.

B. Splice reinforcing steel using only approved bar tendon couplers, in a manner that ensures the longitudinal axes of the 2 spliced lengths are aligned.

C. Locate reinforcing steel splices a minimum of 1 foot away from casing splices.

D. Centralizers shall be used for the full length of the reinforcing steel to support the reinforcing steel in the center of the hole and to provide at least the specified minimum grout cover. Centralizers shall be provided at 10-foot maximum vertical spacing, with the uppermost centralizer located a maximum of 5 feet from the top of the micropile and the lowermost centralizer located between 2 and 5 feet from the bottom of the micropile.

E. Attach centralizers to the reinforcing steel such that the centralizers (1) are secure enough to withstand installation stresses and (2) permit the free flow of grout without misalignment of the reinforcing steel.

F. Installed reinforcing steel surface shall be clean and free of soil, mud, grease, oil, and other foreign materials.

G. The reinforcing steel with centralizers shall be lowered into the stabilized drill holes to the desired depth without difficulty. Partially inserted reinforcing bars shall not be driven or forced into the hole. If the reinforcing steel cannot be installed into the drill hole without difficulty, remove the reinforcing steel, clean any grout and other foreign material from the surface of the reinforcing steel, clean or redrill the hole, and reinsert the reinforcing steel.

3.04 GROUTING

A. Micropiles shall be grouted the same day the hole is drilled.

B. Grout may be placed before or after installation of the reinforcing steel.

C. Mix the grout as follows:

1. Add the water to the mixer followed by the cement and any admixtures. Admixtures, if used, shall be mixed in accordance with manufacturer's recommendations.

2. Mix the grout with mechanical mixing equipment that produces a uniform and thoroughly mixed grout. The grout shall not contain lumps or any other evidence of poor or incomplete mixing.

3. Agitate the grout continuously until the grout is pumped.

4. Do not add water after the initial mixing.

D. Place the grout within 1 hour of mixing.

E. The grout shall be injected from the lowest point of the drill hole by tremie methods until uncontaminated grout flows from the top of the micropile. The tremie grout may be pumped through grout tubes, hollow stem augers, or drill rods.

F. Grout each micropile in 1 continuous operation. Use grouting procedures that ensure complete continuity of the grout column.

G. If temporary casing is used, the casing shall be extracted in stages. After removing each length of casing, bring the grout level back up to ground level before removing the next length of casing. Maintain the grout at a level above the bottom of the temporary casing adequate to prevent displacement of the grout by material from outside the casing. The tremie pipe or casing shall extend at least 10 feet below the grout level in the drilled hole at all times during grout placement.

H. If grout is placed under pressure:

1. Measure and record the grout quantity and pumping pressure.

2. Use a grout pump equipped with a pressure gauge.

3. Place a second pressure gauge at the point of injection into the top of the micropile.

4. Use pressure gauges capable of measuring pressures of at least 150 psi or twice the actual grout pressure used, whichever is greater.

5. Do not use compressed air to directly pressurize the fluid grout.

I. Grout tubes may remain in the hole after the completion of grouting but shall be filled with grout.

J. Maintain the grout level at or above the micropile cutoff elevation until the grout has set.

K. Provide a positive means of support for maintaining the position of the reinforcing steel until the grout has set.

L. Dispose of excess material resulting from grouting operation in a manner acceptable to the RPR.

M. Grout within the micropiles shall be allowed to attain the minimum specified design strength prior to being loaded.

3.05 GROUND HEAVE AND SUBSIDENCE

A. The grout pressures and grout takes shall be controlled to prevent excessive heave in cohesive soils or fracturing of soil or rock formations.

B. If signs of ground heave or subsidence are observed, immediately notify the RPR and Engineer and suspend the drilling and grouting operations. If the RPR or Engineer determines that the movements require corrective action, take the actions necessary to stop the movement and perform repairs.

3.06 INSTALLATION LOGS

A. Prepare a separate installation log for each micropile.

3.07 ALLOWABLE TOLERANCES

A. Centerline of piling shall not be more than 3 inches from the location indicated on the Contract Drawings.

B. Micropile hole alignment shall be within 2 percent of design alignment. Design alignment is vertical, unless otherwise indicated on the Contract Drawings.

C. Top elevation of pile shall be within +1 inch to -2 inches of the design vertical elevation.

D. Centerline of core reinforcement shall not be more than 3/4 inch from centerline of piling.

E. Grout cover over reinforcing steel shall be a minimum of 2 inches.

F. Casing shall extend to the depth indicated on the structural drawings, +/- 3 inches.

G. Costs of redesign or extra construction caused by incorrectly located piles shall be borne by the Contractor at no additional cost to the Owner

3.08 MICROPILE TESTING

A. General

1. Notify the Engineer at least 10 days prior to performing each load test.

2. Perform each load test in the presence of the Independent Testing Agency representative and the Engineer.

3. The grout for each load test micropile must attain the specified 28-day compressive strength before performing the load test.

4. Throughout load testing, maintain the test site in a condition that is level and free of water.

5. Perform verification and proof load testing in tension in accordance with ASTM D3689 and as indicated herein, except do not use the loading apparatus described as “Tensile Load Applied by Hydraulic Jack(s) Acting Upward at One End of Test Beam(s).

6. Perform verification and proof load testing in compression in accordance with ASTM D1143 and as indicated herein.

7. Unless noted otherwise, perform tension load tests on the same test micropile.

8. Load testing for tension shall follow the Cyclic Load Test Schedules indicated herein unless otherwise indicated.

9. Where specifically indicated, load testing in tension shall be in accordance with ASTM D3689 Procedure B, Maintained Test.

10. The Service Loads (SL) for tension testing shall be equal to the Micropile Capacities indicated on the Contract Drawings.

11. The Contractor shall execute the load tests, document test results, and submit them to the Engineer and the Independent Testing Agency for review and approval.

12. The Independent Testing Agency shall observe and verify the proper execution and recording of the tests. The Independent Testing Agency shall submit to the Engineer documentation certifying the accuracy of the tests and reports, noting any discrepancies if applicable.

13. Random sampling and testing of cement grout for test anchors shall be performed as required by the Engineer to verify strength. Test procedures shall be in accordance to ASTM C109.

14. The Contractor shall determine the size, configuration and details of temporary bearing pads or systems needed to accommodate test loads.

15. Use a load cell at the primary load measurement system. The load cell must:

    a. Be of the bonded electrical resistance strain gauge type.

    b. Have a full-scale range no greater than 150 percent of the maximum test load.

    c. Be moisture resistant.

    d. Be temperature compensated. The maximum temperature sensitivity at zero load shall be +/- 0.05 percent of full scale per degree Fahrenheit.

    e. Have a resolution within +/- 0.025 percent of full scale.

    f. Have an accuracy within +/- 0.25 percent of full scale.

16. Use electronic displacement transducers as the primary movement measurement system. Displacement transducers shall be capable of measuring to 0.001 inch and have enough travel to allow the load test to be performed without resetting.

17. Apply the test loads using a hydraulic jack. Use the gauge in the jack and pressure gauge assembly as the secondary load measurement system. Jack ram travel shall be sufficient to allow the load test to be performed without resetting the equipment. The pressure gauge shall be graduated in 100 psi increments or less.

18. The load cell, the electronic displacement transducers, and the jack and gauge assembly must be calibrated by an authorized laboratory accredited for calibration services. The jack and gauge assembly shall be calibrated as a unit.

19. Use an electronic data acquisition system to simultaneously monitor and record readings from the primary load and displacement measurement systems. The electronic data acquisition system shall continuously take readings at regular intervals from the load cell and electronic displacement transducers.

20. The jacking equipment, including the tendon movement measuring system, shall be stable during all phases of the anchor loading operations. The jack shall be positioned at the beginning of the test such that unloading and repositioning of the jack during the test will not be required.

21. An Alignment Load (AL) shall be applied to the pile prior to setting the movement recording devices. This Alignment Load shall be no more than 10% of the specified Service Load (SL). The dial gauges shall be zeroed at the first setting of the Alignment Load.

3.09 VERIFICATION LOAD TESTING

A. The Contractor shall perform verification load tests on each verification test micropile to verify the capacity of the Engineer's design and the Contractor's proposed installation methods prior to installation of production piles. The maximum verification test load shall not exceed 80 percent of the specified minimum ultimate strength of the threaded reinforcing bar. Verification testing will require the use of larger reinforcing bar and/or multiple reinforcing bars or higher ultimate strength reinforcing bars than will be required for production piles.

B. Location of verification test piles shall be as indicated on the Contract Drawings.

C. Verification test piles shall not be used as production piles.

D. The verification load test results shall be reviewed and accepted by the Engineer prior to beginning production micropile construction.

E. The drilling and grouting methods, casing and reinforcement details, inclination and depth of embedment for the verification test piles shall be identical to the production piles, except where approved otherwise by the Engineer.

F. Perform Cyclic Load verification load testing as follows:

1. Incrementally load and unload the micropile as shown in the following table:

Verification Pile Cyclic Load Test Schedule

LOAD INCREMENT	HOLD TIME (MINUTES)
AL	Until Stable
0.25 SL	2
AL	Until Stable
0.25 SL	2
0.50 SL	2
AL	Until Stable
0.25 SL	2
0.50 SL	2
0.75 SL	2
AL	Until Stable
0.25 SL	2
0.50 SL	2

0.75 SL	2
1.00 SL *	10 or 60 *
AL	Until Stable
0.25 SL	2
0.50 SL	2
0.75 SL	2
1.00 SL	2
1.20 SL	2
1.40 SL	2
1.60 SL	2
1.80 SL	2
2.00 SL **	5
1.50 SL	2
1.00 SL	2
0.50 SL	2
AL	Until Stable

Notes:

AL = Alignment Load = 0.10 SL

SL = Service Load

* Creep test, see requirements below

** Maximum test load

2. At each load increment:

   a. Apply the load in less than 1 minute.

   b. Maintain a constant load for the hold time shown in the load test schedule. Start the hold time as soon as the load increment is fully applied.

   c. Measure and record the top of micropile movement at the end of the hold time.

3. At the first application of 1.00 SL, perform the creep test as follows:

   a. Hold the load for 10 minutes.

   b. Measure and record the top of micropile movement at 1, 2, 3, 4, 5, 6, and 10 minutes.

   c. Plot the top of micropile movement as a function of the logarithm of time from 1 to 10 minutes.

   d. If the movement measured from 1 to 10 minutes is greater than 0.04 inch, continue the creep test as follows:

      1) Hole the load for an additional 50 minutes.

2) Measure and record the top of micropile movement at 15, 20, 25, 30, 45, and 60 minutes.

3) Plot the top of micropile movement as a function of the logarithm of time from 6 to 60 minutes.

4. Plot the applied test load versus the top of micropile movement at each load increment.

G. Each Cyclic Load verification load test shall comply with the following acceptance criteria:

1. For tension testing, the axial movement at the top of the micropile measured from the initial alignment load to the first application of 1.00 SL shall not exceed 1 inch at the end of the 1.00 SL hold time.

2. For compression testing, the axial movement at the top of the micropile measured from the initial alignment load to the first application of 1.00 SL shall not exceed 1 inch at the end of the 1.00 SL hold time.

3. The slope of the applied test load versus the top of micropile movement shall not exceed 0.025 inch per kip at the maximum test load.

4. The creep test movement shall comply with one of the following:

a. For a 10-minute load hold, the movement measured from 1 to 10 minutes shall be less than 0.04 inch.

b. For a 60-minute load hold, the movement measured from 6 to 60 minutes must be less than 0.08 inch and the rate of movement shall be linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

H. Where indicated, perform tension verification load testing in accordance with ASTM D3689 Procedure B.

I. Where indicated, perform compression verification load testing in accordance with ASTM D1143 Procedure B.

J. The Contractor shall submit a written report to the Engineer confirming micropile geometry and construction details within 7 working days after the completion of the verification tests. The report shall include the verification test results. The Engineer will review the report to either confirm the bond lengths as shown in the drawings for micropiles or to provide modifications based upon the results of the verification tests. If modifications to bond length are required, additional verification tests may be required. Such tests shall be conducted by the Contractor.

K. Verification Test Pile Rejection

1. When a micropile fails to meet the acceptance criteria, modifications shall be made to the design, the construction procedures, or both. These modifications include, but are not limited to, installing replacement micropiles, modifying the installation methods, increasing the bond length, regrouting via pre-placed re-grout tubes, or changing the micropile type. Any modification which requires changes to the structure shall have prior review and acceptance of the Engineer. The cause for any modifications of design or construction procedures shall be decided in order to appropriately determine any additional cost implications.

L. After the verification test results have been reviewed and notification is received from the Engineer, verification test micropiles and reaction piles shall be demolished to a depth of 4feet below the underside of the structural foundation slab, unless approved otherwise by the Engineer.

3.10 PRODUCTION PILE PROOF LOAD TESTING

A. The Contractor shall perform proof load tests on a minimum of 8 production micropiles. The piles to be tested will be selected by the RPR and the Engineer.

1. Four proof tests shall be done in accordance with the Cyclic Load Test Schedule.

2. Two proof tests shall be done in accordance with ASTM D3689 Procedure B, except that the maximum test load shall be 160% of the Service Load.

B. Perform Cyclic Load verification load testing as follows:

1. Incrementally load and unload the micropile as shown in the following table:

Production Pile Cyclic Load Test Schedule

LOAD INCREMENT	HOLD TIME (MINUTES)
AL	Until Stable
0.25 SL	2
0.50 SL	2
0.75 SL	2
1.00 SL *	10 or 60 *
1.12 SL	2
1.24 SL	2
1.36 SL	2
1.48 SL	2
1.60 SL **	5
1.20 SL	2
0.80 SL	2
0.40 SL	2
AL	Until Stable

Notes:

AL = Alignment Load = 0.10 SL

SL = Service Load

* Creep test, see requirements below

** Maximum test load

2. At each load increment:

   a. Apply the load in less than 1 minute.

   b. Maintain a constant load for the hold time shown in the load test schedule. Start the hold time as soon as the load increment is fully applied.

   c. Measure and record the top of micropile movement at the end of the hold time.

3. At the first application of 1.00 SL, perform the creep test as follows:

   a. Hold the load for 10 minutes.

   b. Measure and record the top of micropile movement at 1, 2, 3, 4, 5, 6, and 10 minutes.

   c. Plot the top of micropile movement as a function of the logarithm of time from 1 to 10 minutes.

   d. If the movement measured from 1 to 10 minutes is greater than 0.04 inch, continue the creep test as follows:

      1) Hole the load for an additional 50 minutes.

      2) Measure and record the top of micropile movement at 15, 20, 25, 30, 45, and 60 minutes.

      3) Plot the top of micropile movement as a function of the logarithm of time from 6 to 60 minutes.

4. Plot the applied test load versus the top of micropile movement at each load increment.

C. Each Cyclic Load proof load test shall comply with the following acceptance criteria:

1. For tension testing, the axial movement at the top of the micropile measured from the initial alignment load to the first application of 1.00 SL shall not exceed 1 inch at the end of the 1.00 SL hold time.

2. For compression testing, the axial movement at the top of the micropile measured from the initial alignment load to the first application of 1.00 SL shall not exceed 1 inch at the end of the 1.00 SL hold time.

3. The slope of the applied test load versus the top of micropile movement shall not exceed 0.025 inch per kip at the maximum test load.

4. The creep test movement shall comply with one of the following:

   a. For a 10-minute load hold, the movement measured from 1 to 10 minutes shall be less than 0.04 inch.

b. For a 60-minute load hold, the movement measured from 6 to 60 minutes must be less than 0.08 inch and the rate of movement shall be linear or decreasing in time logarithmic scale from the 6- to the 60-minute reading.

D. Where indicated, perform tension proof load testing in accordance with ASTM D3689 Procedure B, except that the maximum test load shall be 160% of the Service Load.

E. Where indicated, perform compression proof load testing in accordance with ASTM D1143 Procedure B, except that the maximum test load shall be 160% of the Service Load.

3.11 PROOF TEST PILE REJECTION

A. When a micropile fails to meet the acceptance criteria, modifications shall be made to the design, the construction procedures, or both. These modifications include, but are not limited to, installing replacement micropiles, modifying the installation methods, increasing the bond length, regrouting via pre-placed re-grout tubes, or changing the micropile type. Any modification which requires changes to the structure shall have prior review and acceptance of the Engineer. The cause for any modifications of design or construction procedures shall be decided in order to appropriately determine any additional cost implications.

3.12 INSPECTION

A. Inspector Responsibilities

1. Drilling

a. Prepare soil/excavation logs for each hole. Confirm length of bond zone.

b. Confirm stability of each hole and record specific methods used to maintain hole stability.

c. Verify final depth of hole.

d. Record casing type and length for temporary casings.

e. Record observations made during drilling.

f. Check allowable tolerances.

2. Casing

a. Verify and record permanent casing pipe size, length, material properties and connections just prior to insertion into the drill hole.

3. Reinforcement

a. Verify bar size, length, and condition just prior to insertion into the drill hole.

b. Verify size and condition of bar couplers (where applicable).

c. Verify installation.

d. Verify location of centralizers.

4. Grouting

    a. Verify hole cleanliness.

    b. Observer dry cement for indications of hydration.

    c. Verify water/cement ratio and grout mix designs.

    d. Verify that all grouting equipment (pumps, gauges, hoses, etc.) are in good working order.

    e. Record grout volumes and pressures for each micropile.

    f. Observe quality of grout at ground surface.

    g. Collect grout samples and perform required conformance testing.

B. Before reinforcement is installed into the drilled hole it shall be inspected by the RPR. If the reinforcement assembly is defective, damaged and/or otherwise unsatisfactory to the Engineer, it shall be replaced to the satisfaction of the Engineer and at no additional cost to the Owner.

C. The Engineer shall observe the installation of the micropiles. The Engineer shall be notified at least 48 hours prior to micropile installation or testing.

D. Final Inspection: After installation and testing, and prior to casting the concrete slab, the Engineer shall inspect the micropile anchorages to ensure that they have been prepared for concrete embedment. Any anomalies regarding anchorage preparation for embedment shall be remedied by the Contractor to the Engineer's satisfaction.

3.13 NON-CONFORMING WORK

A. Micropile work not conforming to the requirements indicated on the Structural Drawings and the Specifications shall be repaired or removed by the Contractor as directed by the Engineer.

B. Micropile work that is required to be removed shall be demolished to demolished to a depth of 1 foot below the underside of the structural foundation slab, unless approved otherwise by the Engineer.

C. All repair work is subject to the approval of the Engineer.

D. Non-conforming pile work includes, but is not limited to:

1. Micropiles that fail to develop the load capacities indicated on the Contract Drawings, including the specified factor of safety.

2. Micropiles that include any defect that reduces the structural integrity of the pile. Examples of such defects include:

    a. Micropiles with concrete that is cracked, fractured or spalled.

    b. Micropiles with spalled concrete.

    c. Micropiles that contain voids or foreign material.

d. Micropiles with a cross-sectional area less that specified.

e. Micropiles with concrete strength less than the specified minimum 28-day compressive strength.

f. Micropiles that contain reinforcing steel not installed for the full length of the pile.

g. Micropiles with damaged epoxy coating.

h. Micropiles with improper splicing of casing or reinforcing steel.

i. Micropiles with temporary casing not removed.

j. Micropiles that fail to meet the allowable tolerance requirements.

k. Micropiles that contain any other defect as determined by the Engineer that would weaken the pile

END OF SECTION

SECTION 32 11 13 – HOT MIX ASPHALT AND BASE

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The Contractor shall provide and place one or more layers of plant-mixed hot mix asphalt (HMA) or asphalt treated base (ATB) on a prepared foundation or base in accordance with these Specifications and the lines, grades, thicknesses, and typical cross-sections shown in the Plans. The manufacture of HMA may include warm mix asphalt (WMA) processes in accordance with these Specifications. WMA processes include organic additives, chemical additives, and foaming.

B. HMA and ATB shall be composed of asphalt binder and mineral materials as may be required, mixed in the proportions specified to provide a homogeneous, stable, and workable mixture.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

B. Washington State Department of Transportation 2025 Standard Specifications for Road, Bridge and Municipal Construction (WSDOT)

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures. Include materials testing reports, job-mix formulas, and other pertinent information satisfactory to the Engineer.

B. Suitability Tests of Proposed Materials**:** Tests for conformance with the Specifications shall be performed prior to start of the Work. The samples shall be identified to show the name of the material, aggregate source, name of the supplier, contract number, and the segment of the WORK where the material represented by the sample is to be used. Results of all tests shall be submitted to the Engineer for approval. Materials to be tested shall include aggregate base, coarse and fine aggregate for paving mixtures, mineral filler, and asphalt cement.

C. Trial Batch**:** Before placing any paving material, a testing laboratory acceptable to the Engineer shall prepare a trial batch of asphalt concrete for each job-mix formula to be used by the Contractor for the Work. The trial batch shall be prepared using the aggregates and asphalt cement proposed by the Contractor, and approved by the Engineer. The compacted trial batch shall provide a basis for computing the voids ratio, provide an indication of the optimum asphalt content, and establish a basis for controlling compaction during construction. The cost of not more than 2 laboratory trial batch tests will be paid by the Owner but the Contractor shall be responsible for the materials. Performing and paying for any additional trial batch testing shall be the Contractor’s responsibility.

PART 2 -- PRODUCTS

2.1 AGGREGATE BASE

A. Gravel base shall consist of granular material and be free from various types of wood waste or other extraneous or objectionable materials. It shall have such characteristics of size and shape that it will compact readily, and the maximum particle size shall not exceed ⅔ of the depth of the layer being placed.

B. Gravel base shall meet the following gradation requirements:

Sieve Size	Percent Passing
2”	75-100
No 4	22-100
No 200	0-10
Dust Ratio	2/3 max
Sand Equivalent	30 min

C. Gravel base material retained on a No 4 sieve shall contain not more than 0.20 percent by weight of wood waste.

2.2 PRIME COAT

A. Prime coat shall be Grade SC-250 liquid asphalt complying with the requirements of AASHTO M 82 (ASTM D 2027). Grade SC-70 liquid asphalt may be used when acceptable to the Engineer.

2.3 TACK COAT

A. Tack coat shall be cationic emulsified asphalt CSS-1, CSS-1h, or Performance Graded (PG) asphalt. The CSS-1 and CSS-1h may be diluted with water at a rate not to exceed one part water to one part emulsified asphalt

B. Do not allow the tack coat material to exceed the maximum temperature recommended by the asphalt supplier.

2.4 PERFORMANCE GRADED ASPHALT BINDER (PGAB)

A. PGAB meeting the requirements of AASHTO M 320 Table 1 of the grades specified shall be used in the production of HMA. For HMA with greater than 20 percent RAP by total weight of HMA, or with any amount of RAS, the new asphalt binder, recycling agent and recovered asphalt (RAP and/or RAS) when blended in the proportions of the mix design shall meet the PG asphalt binder requirements of AASHTO M332 Table 1 for the grade of asphalt binder specified.

B. Performance grade asphalt binder shall be PG 58V-22 and be on the approved WSDOT Qualified Products List (QPL).

2.5 AGGREGATE FOR HOT MIX ASPHALT

A. Aggregates for hot mix asphalt shall be manufactured from ledge rock, talus, or gravel. The material from which they are produced shall meet the following test requirements:

Los Angeles Wear, 500 Rev.	30% max.
Degradation Factor, Wearing Course	30 min.
Degradation Factor, Other Courses	20 min.

B. Aggregate sources that have 100 percent of the mineral material passing the No 4 sieve shall be limited to no more than 5 percent of the total weight of aggregate.

C. Aggregates shall be uniform in quality, substantially free from wood, roots, bark, extraneous materials, and adherent coatings. The presence of a thin, firmly adhering film of weathered rock will not be considered as coating unless it exists on more than 50 percent of the surface area of any size between consecutive laboratory sieves.

D. Aggregate removed from deposits contaminated with various types of wood waste shall be washed, processed, selected, or otherwise treated to remove sufficient wood waste so that the oven dried material retained on a No. 4 sieve shall not contain more than 0.1 percent by weight of material with a specific gravity less than 1.0.

E. Aggregate shall be 3/4"-0 meeting the following gradation requirements:

Sieve Size	Aggregate Gradation Control Points
1”	99-100
3/4"	90-100
1/2"	90 Maximum
No 8	23-49
No 200	2.0-7.0

PART 3 -- EXECUTION

3.1 HMA MIXING PLANT

A. Plants used for the preparation of HMA shall conform to the requirements of WSDOT Standard Specification Section 5-04.3(1) HMA Mixing Plant.

3.2 HAULING EQUIPMENT

A. Trucks used for hauling HMA shall have tight, clean, smooth metal beds and shall have a cover of canvas or other suitable material of sufficient size to protect the mixture from adverse weather. Whenever the weather conditions during the work shift include, or are

forecast to include, precipitation or an air temperature less than 45 degrees F, the cover shall be securely attached to protect the HMA.

B. In order to prevent the HMA mixture from adhering to the hauling equipment, truck beds are to be sprayed with an environmentally benign release agent. Excess release agent shall be drained prior to filling hauling equipment with HMA. Petroleum derivatives or other coating material that contaminate or alter the characteristics of the HMA shall not be used. For hopper trucks, the conveyer shall be in operation during the process of applying the release agent.

C. At the time of delivery to the Site, the temperature of mixture shall not be lower than 260 degrees F or higher than 320 degrees F, the lower limit to be approached in warm weather and the higher in cold weather.

D. Hauling equipment for ATB shall conform to the requirements stated above for HMA, except that the temperature of the mixture at the time compaction is achieved shall be a minimum of 185 degrees F.

3.3 HOT MIX ASPHALT PAVERS

A. HMA pavers shall be self-contained, power-propelled units, provided with an internally heated vibratory screed and shall be capable of spreading and finishing courses of HMA plant mix material in lane widths required by the paving section shown in the Plans.

B. Prior to the use of any HMA paver, the Contractor shall certify the paver meets the requirements of WSDOT Standard Specification Section 5-04.3(3) and is equipped with the most current equipment available from the manufacturer for the prevention of the segregation of the coarse aggregate particles. The certification shall list the make, model, and year of the paver and any equipment that has been retrofitted to the paver.

C. The transverse slope controller shall be capable of maintaining the screed at the desired slope within plus or minus 0.1 percent. The paver shall be equipped with automatic feeder controls, properly adjusted to maintain a uniform depth of material ahead of the screed. Manual operation of the screed will be permitted in the construction of irregularly shaped and minor areas.

D. The Contractor shall furnish and install all pins, brackets, tensioning devices, wire, and accessories necessary for satisfactory operation of the automatic control equipment.

3.4 MATERIAL TRANSFER DEVICE/VEHICLE

A. Direct transfer of HMA from the hauling equipment to the paving machine will not be allowed in the top 0.30 foot of the pavement section of hot mix asphalt (HMA) used in traffic lanes with a depth of 0.08 foot or greater. A material transfer device or vehicle (MTD/V) shall be used to deliver the HMA from the hauling equipment to the paving machine. HMA placed in irregularly shaped and minor areas such as road approaches, tapers, and turn lanes are excluded from this requirement.

B. The MTD/V shall mix the HMA after delivery by the hauling equipment and prior to laydown by the paving machine. Mixing of the HMA shall be sufficient to obtain a uniform temperature throughout the mixture. If a windrow elevator is used, the length of the windrow may be limited in urban areas or through intersections, at the discretion of the Engineer.

3.5 ROLLERS

A. Rollers shall be of the steel wheel, vibratory, or pneumatic tire type, in good condition and capable of reversing without backlash. Operation of the roller shall be in accordance with the manufacturer's recommendations. When ordered by the Engineer for any roller planned for use on the project, the Contractor shall provide a copy of the manufacturer's recommendation for the use of that roller for compaction of HMA. The number and weight of rollers shall be sufficient to compact the mixture in compliance with the requirements of Section 5-04.3(10). The use of equipment that results in crushing of the aggregate will not be permitted. Rollers producing pickup, washboard, uneven compaction of the surface, displacement of the mixture or other undesirable results shall not be used.

3.6 SUBGRADE PREPARATION

A. The subgrade shall be prepared in accordance with Section 31 30 00 - Earthwork as applicable to roadways and embankments. The surface of the subgrade after compaction shall be hard, uniform, smooth and true to grade and cross-section. Subgrade for pavement shall not vary more than 0.02-foot from the indicated grade and cross section. Subgrade for base material shall not vary more than 0.04-foot from the indicated grade and cross section.

3.7 AGGREGATE BASE

A. Aggregate base shall be provided where indicated to the thickness indicated. Imported aggregate bases shall be delivered to the Site as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free of pockets of coarse or fine material. Where the required thickness is 6-inches or less, the base materials may be spread and compacted in one layer. Where the required thickness is more than 6 inches; the base material shall be spread and compacted in two or more layers of approximately equal thickness, and the maximum compacted thickness of any one layer shall not exceed 6 inches. The relative compaction of each layer of aggregate base shall be not less than 95 percent of maximum density when measured in accordance with ASTM D 1557. The compacted surface of the finished aggregate shall be hard, uniform, smooth and at any point shall not vary more than 0.02 foot from the indicated grade or cross-section.

3.8 PRIME COAT

A. Prior to placing of pavement, a prime coat of cutback asphalt shall be applied to the compacted base or subgrade at a rate between 0.10 and 0.25 gal/sq yd.

3.9 PREPARATION OF EXISTING SURFACES AND TACK COAT

A. Before construction of HMA or HMA reinforcing grid on an existing paved surface, the entire surface of the pavement shall be clean. All fatty asphalt patches, grease drippings, and other

objectionable matter shall be entirely removed from the existing pavement. All pavements or bituminous surfaces shall be thoroughly cleaned of dust, soil, pavement grindings, and other foreign matter. All holes and small depressions shall be filled with an appropriate class of HMA. The surface of the patched area shall be leveled and compacted thoroughly.

3.10 TACK COAT

A. A tack coat of asphalt shall be applied to all paved surfaces on which any course of HMA is to be placed or abutted. Tack coat shall be uniformly applied to cover the existing pavement with a thin film of residual asphalt free of streaks and bare spots. A heavy application of tack coat shall be applied to all joints. For Roadways open to traffic, the application of tack coat shall be limited to surfaces that will be paved during the same working shift. The spreading equipment shall be equipped with a thermometer to indicate the temperature of the tack coat material.

B. A tack coat shall be applied to all paved surfaces on which any course of HMA is to be placed or abutted. It shall also be applied to the contact surfaces of all cold pavement joints, curbs, gutters, manholes and the like immediately before the adjoining asphalt pavement is placed.

1. Care shall be taken to prevent the application of tack coat material to surfaces that will not be in contact with the new asphalt concrete pavement.

2. Tack coat shall be uniformly applied to cover the existing pavement with a thin film of residual asphalt free of streaks and bare spots. A heavy application of tack coat shall be applied to all joints.

3. For Roadways open to traffic, the application of tack coat shall be limited to surfaces that will be paved during the same working shift. The spreading equipment shall be equipped with a thermometer to indicate the temperature of the tack coat material.

4. Equipment shall not operate on tacked surfaces until the tack has broken and cured. If the Contractor’s operation damages the tack coat, it shall be repaired prior to placement of the HMA.

5. The tack coat shall not exceed the maximum temperature recommended by the emulsified asphalt manufacturer.

6. Diluted emulsified asphalt shall be applied at the rate of 0.05 to 0.15 gal/sq yd. Undiluted emulsified asphalt shall be applied at the rate of 0.025 to 0.075 gal/sq yd.

3.11 MIX DESIGN

A. The Contractor shall develop a mix design prior to the initial production of HMA and prior to the production of HMA each calendar year thereafter. The mix design aggregate structure and asphalt binder content shall be determined in accordance with WSDOT Standard Operating Procedure 732 and meet the requirements of WSDOT Standard Specification Sections 9-03.8(2) and 9-03.8(6). Mix designs that were developed during the calendar year

prior to the current year's production of HMA that have been issued a WSDOT mix design report will be accepted provided the Contractor submits a certification letter stating that the aggregate and asphalt binder have not changed.

B. Changes to aggregate that may require a new mix design include the source of material or a change in the percentage of material from a stockpile greater than 5 percent. Changes to asphalt binder that may require a new mix design include the source of the crude petroleum supplied to the refinery, the refining process, and additives or modifiers in the asphalt binder.

C. Mix designs for HMA accepted by commercial evaluation shall be submitted to the Engineer on DOT form 350-042; only the first page is required. Verification of the mix design by the Contracting Agency is not required. The Engineer will determine anti-strip requirements for the HMA. Paving shall not begin before the anti-strip requirements have been provided to the Contractor. For commercial HMA, the Contractor shall select a class of HMA and design level of Equivalent Single Axle Loads (ESALs) appropriate for the required use.

3.12 SPREADING AND FINISHING

A. The HMA mixture shall be laid upon an approved surface, spread, and struck off to the grade and elevation established. HMA pavers complying with Article 3.3 shall be used to distribute the mixture. Unless otherwise directed by the Engineer, the nominal compacted depth of any layer of any course shall not exceed the following:

HMA Class 1"	0.35-feet
HMA Class 3/4" and HMA Class 1/2"	
Wearing course	0.30-feet
Other courses	0.35-feet
HMA Class 3/8"	0.10-feet

B. HMA and ATB shall be evenly spread upon the subgrade or base to such a depth that, after rolling, it will be of the required cross-section and grade of the course being constructed.

C. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the paving may be done with other equipment or by hand.

3.13 COMPACTION

A. Immediately after the HMA has been spread and struck off, and after surface irregularities have been adjusted, the mix shall be thoroughly and uniformly compacted. The completed course shall be free from ridges, ruts, humps, depressions, objectionable marks, and irregularities and shall conform to the line, grade, and cross-section shown in the Plans.

B. Compaction shall take place when the mixture is in the proper condition so that no undue displacement, cracking, or shoving occurs. Areas inaccessible to large compaction equipment shall be compacted by mechanical or hand tampers. Any HMA that becomes loose, broken, contaminated, shows an excess or deficiency of asphalt, or is in any way

defective, shall be removed and replaced with new hot mix that shall be immediately compacted to conform to the surrounding area.

C. The type of rollers to be used and their relative position in the compaction sequence shall generally be the Contractor's option, provided the specified densities are attained. An exception shall be that pneumatic tired rollers shall be used for compaction of the wearing course beginning October 1st of any year through March 31st of the following year. Coverages with a vibratory or steel wheel roller may precede pneumatic tired rolling. Unless the Engineer has approved otherwise, vibratory rollers shall not be operated in the vibratory mode when the internal temperature of the mix is less than 175 degrees F. Regardless of mix temperature, a vibratory roller shall not be operated in a vibratory mode when checking or cracking of the mat occurs.

D. The relative density of HMA after compaction shall be 95 percent of the density obtained by using ASTM D 1188 or D 2726. ATB shall be compacted to a density of not less than 80 percent. A properly calibrated nuclear asphalt testing device shall be used for determining the field density of compacted asphalt concrete, or slabs or cores may be laboratory tested in accordance with ASTM D 1188.

3.14 JOINTS

A. Transverse Joints:

1. The Contractor shall conduct operations such that the placing of the top or wearing course is a continuous operation or as close to continuous as possible. Unscheduled transverse joints will be allowed and the roller may pass over the unprotected end of the freshly laid mixture only when the placement of the course must be discontinued for such a length of time that the mixture will cool below compaction temperature. When the Work is resumed, the previously compacted mixture shall be cut back to produce a slightly beveled edge for the full thickness of the course.

2. A temporary wedge of HMA constructed on a 50H:1V shall be constructed where a transverse joint as a result of paving or planning is open to traffic. The HMA in the temporary wedge shall be separated from the permanent HMA by strips of heavy wrapping paper or other methods approved by the ENGINEER. The wrapping paper shall be removed and the joint trimmed to a slightly beveled edge for the full thickness of the course prior to resumption of paving.

3. The material that is cut away shall be wasted and new mix shall be laid against the cut. Rollers or tamping irons shall be used to seal the joint.

B. **Longitudinal Joints:** The longitudinal joint in any one course shall be offset from the course immediately below by not more than 6 inches nor less than 2 inches. All longitudinal joints constructed in the wearing course shall be located at a lane line or an edge line of the Traveled Way.

3.15 SURFACE SMOOTHNESS

A. The completed surface of all courses shall be of uniform texture, smooth, uniform as to crown and grade, and free from defects of all kinds. The completed surface of the HMA wearing course shall not vary more than 1/8 inch from the lower edge of a 10-foot straightedge placed on the surface parallel to the centerline. The transverse slope of the completed surface of the wearing course shall vary not more than 1/4 inch in 10 feet from the rate of transverse slope shown in the Plans.

B. The final surface course of ATB, excluding shoulders, shall not deviate at any point more than 3/8 inch from the bottom of a 10-foot straightedge laid in any direction on the surface on either side of the Roadway crown. Failure to meet this requirement shall necessitate sufficient surface correction to achieve the required tolerance, as approved by the Engineer, at no expense to the Contracting Agency.

C. Correction of defects shall be carried out until there are no deviations anywhere greater than the allowable tolerances.

3.16 ADJUSTING MANHOLES AND CATCH BASINS TO GRADE

A. The Contractor shall adjust manhole castings to final grade by adding concrete adjusting rings, brick and/or mortar under the casting, and patching with asphalt concrete. Paving adjusting rings will not be allowed. Adjustment bricks and rings shall be coated with 1-inch-thick concrete mortar on interior and exterior surfaces. All rings and bricks shall be grouted to the existing structure.

B. The Contractor shall prevent foreign material from entering the manhole.

C. All manholes shall be adjusted to grade after the asphalt concrete surfacing has been placed. Disturbed area around cover shall be patched and sealed to the satisfaction of the Engineer.

D. The Contractor shall set the top of the manholes at finished grade such that the finished roadway surface meets the requirements set forth in Article 3.13 – Surface Smoothness.

3.17 ADJUSTING MONUMENT CASES, VALVES BOXES, AND ELECTRICAL BOXES TO GRADE

A. Monument cases and/or valve boxes and electrical boxes shall be adjusted to final grade and patched with asphalt concrete, with a 6-inch-thick, 1-foot-wide cement concrete collar on the exterior of the case or box, recessed 1 inch below the finished grade for the final asphalt concrete patch. Paving adjusting rings will not be allowed.

B. Adjustment shall be made after the resurfacing.

C. Patching around monument cases and/or valve boxes shall be done to the satisfaction of the Engineer.

D. The Contractor shall set the top of castings at the finished grade such that the finished roadway surface meets the requirements set forth in Article 3.13 – Surface Smoothness.

3.18 PLANING BITUMINOUS PAVEMENT

A. Planing shall be performed in such a manner that the underlying pavement is not torn, broken, or otherwise damaged by the planing operation. Delamination or raveling of the underlying pavement will not be construed as damage due to the Contractor's operations. Pavement outside the limits shown in the Plans or designated by the Engineer that is damaged by the Contractor's operations shall be repaired to the satisfaction of the Engineer, at the Contractor's expense.

B. The planings and other debris resulting from the planing operation shall become the property of the Contractor and properly disposed of off-site.

3.19 WEATHER LIMITATIONS

A. HMA for wearing course shall not be placed on any Traveled Way beginning October 1 through March 31 of the following year without written approval from the Engineeer.

B. HMA shall not be placed on any wet surface, or when the average surface temperatures are less than those specified in the following table, or when weather conditions otherwise prevent the proper handling or finishing of the bituminous mixtures:

	Surface Temperature Limitation	
Compacted Thickness (Feet)	Wearing Course	Other Courses
Less than 0.10	55°F	45°F
0.10 to 0.20	45°F	35°F
More than 0.20	35°F	35°F

END OF SECTION

SECTION 32 31 13 – CHAIN LINK FENCES AND GATES

PART 1 -- GENERAL

1.01 SUMMARY

A. Section Includes:

1. This section specifies the requirements for materials and installation for chain link fencing and gates and appurtenant work.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
03 30 50	Cast-in-Place Concrete

C. Reference Standards

ASTM International (ASTM)	
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A116	Standard Specification for Metallic-Coated, Steel Woven Wire Fence Fabric
ASTM A153/A153M	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A702	Standard Specification for Steel Fence Posts and Assemblies, Hot Wrought
ASTM A780/A780M	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A90/A90M	Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
ASTM B117	Standing Practice for Operating Salt Spray (Fog) Apparatus
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM F1043	Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F1083	Standard Specification for Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded, for Fence Structures
ASTM F567	Standard Practice for Installation of Chain Link Fence
ASTM F626	Standard Specification for Fence Fittings
ASTM G152	Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials
ASTM G153	Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

ASTM G154	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
ASTM G155	Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
ASTM F1184	Standard Specification for Industrial and Commercial Horizontal Slide Gates

1.03 SUBMITTALS

A. General

1. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Manufacturer's technical data, product specifications, standard details, certified product test results, installation instructions and general recommendations.

2. Scale layout of fencing, gates, and accessories. Drawings shall show fence height, post layout, including sizes and sections; post setting and bracing configuration, details of gates and corner construction, barbed wire support arms, and other accessories.

C. Samples

1. Samples of proposed fence components, at least 12-in long, to illustrate the selected color and finish.

1.04 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers

a. Chain link fencing and gates shall be products of a single manufacturer which has been successfully engaged in the production of such items for a period of at least 5 years

2. Installers

a. Installation of the chain link fence shall be by the manufacturer or by a firm accepted and licensed by the manufacturer.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Provide fencing materials conforming to the requirements of ASTM A116, ASTM A702, ASTM F626 and as specified.

B. Dimensions indicated herein for roll-formed pipe and wire gauges are outside dimensions, excluding coatings.

C. All fencing materials shall be hot-dip galvanized after fabrication.

2.02 STEEL FABRIC

A. The height of the fabric shall be 8 feet.

B. Provide fabric consisting of No. 9 gauge wires woven into a 2-in diamond mesh, with dimensions of fabric and wire conforming to ASTM A116, ASTM A702 and ASTMF 626.

C. Fabric shall be galvanized in accordance with ASTM A392, Class I, with minimum 1.2 oz zinc per sq ft of coated surface.

D. Poly Vinyl Chloride (PVC) color coated steel chain link fabric per ASTM F668 Class Class 1 Extruded over metallic coated steel wire, except that the wire core shall measure 9 gauge prior to application of coating. Color of chain link fabric shall be as indicated by the Owner per ASTM F934.

E. Fabric shall be furnished with knuckle top and bottom selvages.

2.03 FENCE FRAMEWORK

A. Posts and Rails

1. Posts and Rails hot-dip galvanized cold rolled welded ASTM A53, Grade A, Schedule 40 steel pipe, with minimum 1.8 ounces zinc per square foot of coated surface.

2. After galvanizing, framework, fittings, and accessories shall be finished with manufacturer's standard thermally bonded PVC finish, not less than 10-mils thick.

3. Post and Rail Dimension Schedule

	Fabric Height		
Component	< 6 ft	≥ 6 ft and ≤ 8 ft	> 8 ft
Line Post	1.900-in OD 0.145-in wall	2.375-in OD 0.154-in wall	2.875-in OD 0.203-in wall
Terminal Post End and Corners	2.875-in OD 0.203-in wall	3.500-in OD 0.216-in wall	4.500-in OD 0.237-in wall
Rail and Brace	1.660-in 0.140-in wall		

	Gate Panel Width (opening size for single swing gates or half of opening size for double swing gates)		
Component	< 10 ft	≥ 10 ft and < 15 ft	≥ 15 ft and ≤ 25 ft
Terminal Post Gates	3.500-in OD 0.216-in wall	4.500-in OD 0.237-in wall	6.625-in OD 0.280-in wall

2.04 FENCE HARDWARE, FITTINGS, AND ACCESSORIES

A. Fence Hardware, Fittings, and Accessories shall conform to ASTM F626. Sleeves, bands, clips, tension bars, fastener and fittings, shall be galvanized with minimum 1.2 oz per sq ft of coated surface.

B. Tension Wire

1. Tension wire shall be located at the bottom of the fabric and shall consist of No. 9 gauge coated coil spring wire of metal and finish to match fabric.

C. Fabric Tie Wires

1. Fabric tie wires shall be No. 9 gauge galvanized steel wire of the same finish as the fabric. Aluminum ties shall not be used.

D. Post Brace Assembly

1. Post brace assembly shall be provided at each end post, gate post and at both sides of each corner post and intermediate brace post. Material used for brace shall be same as top rail. Truss bracing between line posts shall be achieved with 0.375-in diameter rod and adjustable drop forged turnbuckle type tensioner.

E. Post Tops and Rail Ends

1. Post tops and rail ends shall be cast aluminum, cast iron, or pressed steel weather-tight closure caps, designed for containment of top rail and positive permanent attachment to post.

F. Tension (Stretcher) Bars

1. Stretcher bars shall be one-piece lengths equal to the full height of the fabric, with minimum cross-section of 3/16-in by ¾-in. One stretcher bar shall be provided for each gate and end post, and 2 for each corner and intermediate brace post.

G. Tension (Stretcher) Bar Bands

1. Stretcher bar bands shall be one-piece fabrications designed to secure stretcher bars to end, corner, intermediate brace, and gate posts. Bands shall have a minimum cross-section of 1/8-in by ¾-in.

H. Barbed Wire Supporting Arms

1. Supporting arms shall be manufacturer’s standard fabrication, of metal and finish to match fence framework, with provision for anchorage to each post and attachment of three rows of barbed wire to each arm. Supporting arms may be either attached to posts or integral with post top weather cap.

2. Supporting arm shall hold three strands of barbed wire, top strand to be 12-in above fabric; vertical or at 45 degree overhang, as specified. 45 degree arm type shall be capable of withstanding 250 lb of downward pull at outermost end.

I. Barbed Wire

1. Barbed wire shall conform to ASTM A121, with three strands, 2 12.5 gauge wires per strand. Each wire shall be zinc-coated with minimum 0.8 oz zinc per sq ft of coated surface. Barbs to have 4 points spaced at a maximum of 6-in.

J. Nuts, bolts and screws shall be steel, minimum size 3/8-in diameter, hot-dip galvanized after fabrication.

2.05 GATES

A. Fabrication

1. Perimeter frames of gates swing shall be fabricated from same metal and finish as fence framework. Gate frames shall be assembled by welding. Welds shall be ground smooth. Gate frames and any ungalvanized hardware, shall be hot-dip galvanized after fabrication. Horizontal and vertical members shall be provided to ensure proper gate operation and attachment of fabric, hardware and shall be hot-dip galvanized after fabrication.

2. Fabric for gates shall match fence fabric, unless otherwise indicated. Fabric shall be installed with tension (stretcher) bars at all perimeter edges. Tension (stretcher) bars shall be attached to gate frame with tension (stretcher) bar bands spaced no more than 15-in on center.

3. Where barbed wire is indicated above gates, vertical members shall be extended and fabricated as required to receive barbed wire supporting arms.

B. Horizontal Slide Gates

1. Horizontal slide gates shall be fabricated in accordance with fabricated in accordance with ASTM F1184.

2. Gate Operator

a. Automatic opening gates shall be complete with equipment mounting concrete pads, motorized operators, hardware, controls, and vehicle detector loop. Vehicular traffic encompasses light duty pick-up trucks, automobiles, to tractor-trailer trucks.

b. The automatic operator motor shall be 2 HP, 208 V, three-phase and of adequate power to operate the gate under all weather conditions. The unit shall be equipped with a control power transformer to derive service power when the unit is serviced. The automatic gate operator shall be as manufactured by HySecurity SlideDriver 222 SS, or approved equal.

1) Each automatic operator shall be housed in a NEMA 3R enclosure, containing relays, motor starters, control power transformers, power supplies, controller and all necessary devices that compose a fully equipped operator. The unit shall be UL 325 and UL 991 compliant.

2) The automatic limit switch shall be self-adjusting and unaffected by gearbox variances.

3) The operator will include a secure but convenient override to allow manual operation of the gate.

c. The automatic gate operator shall be supplied with vehicle loop detectors and preformed or field formed loops for installation on the roadway surface.

1) The automatic gate operator shall be equipped with inside and outside safety/reverse loops, and free exit loops. The loops shall be of the of copper, and a road rated box shall be provided to route all the loop wiring to the automatic gate operator housing in conduit.

2) Any chains of the automatic operator shall be stainless steel.

3) The automatic operator shall be equipped with all necessary accessories for a fully functional system. The Contractor shall coordinate connecting the automatic gate operator to the Owner's network.

2.06 CONCRETE

A. Concrete shall be provided in accordance with Section 03 30 50 - Cast-In-Place Concrete, ASTM C94/C94M, and the following mix design:

Parameter	**Value**
Min. 28 Day Compressive Strength	2900 psi
Slump	2 3/8 ±3/4-in
Entrained Air Limits (percent by volume)	6 percent
Max. Aggregate Size	0.75-in
Max. Water to Cementing Materials Ratio (by mass)	0.45
Min. Portland Cement Content	18 lbs/ft^3
Cement Type	ASTM C150 Type V (Sulphate Resistant Concrete)

PART 3 -- EXECUTION

3.01 INSPECTION

A. Prior to commencing installation, the Installer shall inspect all areas and conditions within which Work of this Section will be performed. Dimensions and clearances shall be verified. Final grading shall be completed and all earth, brush, or other obstructions which interfere with the proper alignment and construction of fencing shall be removed.

3.02 INSTALLATION

A. General

1. Fencing and gates shall be installed in accordance with ASTM F567.

2. Unless otherwise indicated, all posts shall be set in concrete. Gate and related posts, corner posts, and other critical elements shall be provided with concrete foundations.

B. Excavation

1. Holes for post footings shall be drilled to the diameters, depths, and spacings indicated on the drawings, in firm, undisturbed or compacted soil.

2. Uniformly spread soil from excavations adjacent to the fence line.

C. Setting Posts

1. Space line post footings at a maximum of 10 ft on center and parallel to the ground slope

2. Posts shall be set plumb and shall be centered in holes, 4-in above the bottom of the excavation, with posts extending not less than 36-in below finish grade surface. Set posts deeper, as required, in soft and problem soils and for heavy, lateral loads.

3. Corner posts shall be installed where changes in the fence lines equal or exceed 10 degrees, measured horizontally.

4. Each post shall be properly aligned vertically. Posts shall be maintained in proper position during placement and finishing operations.

D. Concrete

1. Concrete for footings may be placed without forms, providing the ground is firm enough to permit excavation to neat line dimensions. Prior to placing concrete, the earth around the hole shall be thoroughly moistened.

2. Encasement concrete for footings shall be placed immediately after mixing in a manner such that there will be no concentration of the large aggregates. The concrete shall be consolidated by tamping or vibrating.

3. Concrete shall cure for a minimum of 7 days prior to installation of fence fabric or barbed wire.

E. Bracing

1. Bracing shall be provided at all ends, corners, gates, and intermediate brace posts. Corner posts and intermediate brace posts shall be braced in both directions. Horizontal brace rails shall be set midway between the top rail and the ground, running from the corner, end, intermediate brace or gate post to the first line post. A diagonal tension member shall connect tautly between posts below horizontal braces.

2. Where straight runs of fencing exceed 500 ft, intermediate brace posts shall be installed, spaced equally between ends or corners; with additional posts provided as required. Intermediate brace posts shall be equivalent in size to corner posts and shall be braced with horizontal brace rails and diagonal tension members in both directions.

F. Top Rails

1. Top rails shall be run continuously through post caps, bending to radius for curved runs. Expansion couplings shall be provided as recommended by the fencing manufacturer.

G. Tension Wire

1. Continuous bottom tension wire shall be stretched tight with turnbuckles at end, gate, intermediate, and corner posts.

2. Tension wire shall be installed on a straight grade between posts, with approximately 2-in of space between finish grade and bottom selvage, unless otherwise indicated.

3. Tension wire shall be tied to each post with not less than 6 gauge galvanized wire. Tension wire shall be interlaced with the fabric or attached to the fabric along the extreme bottom of the fence.

H. Fabric Installation

1. Chain-link fabric shall be fastened on the secured side of the posts.

2. Fabric shall be stretched and securely fastened to posts. Between posts, top and bottom edges of the fabric shall be fastened to the top rail and bottom tension wire, respectively.

3. Fabric shall be stretched and anchored in such a manner that it remains in tension after the pulling force is released.

I. Tie-Wires

1. Tie wire shall be bent to conform to the diameter of the pipe to which it is attached, clasping pipe and fabric firmly with ends twisted at least two full turns. Ends of wire shall be bent back to minimize hazard to persons or clothing.

2. Fabric shall be tied to line posts with tie wires spaced at 12-in on center.

3. Fabric shall be tied to rails and braces with tie wires spaced at 24-in on center.

4. Fabric shall be tied to tension wires, with hog rings spaced 24-in on center.

J. Tension (Stretcher) Bars:

1. Fabric shall be fastened to end, corner, intermediate brace, and gate posts with tension (stretcher) bars. Bars shall be threaded through or clamped to fabric at 4-in on center and secured to posts with tension (stretcher) bar bands, spaced no more than 14-in on center.

K. Fasteners

1. Nuts for tension bands and hardware bolts shall be installed on the side of fence opposite the fabric side. Ends of bolts shall be peened or the threads scored to prevent removal of nuts.

L. Touch Up

1. Clean damaged galvanized surfaces with wire brush removing loose and cracked coatings. Apply two coats of organic zinc-rich paint to damaged areas.

2. Damage to PVC coating shall be repaired with material equivalent in color and thickness to the original coating.

3.03 GATES INSTALLATION

A. Install gates plumb, level, and secure, with full opening without interference. Install ground set items in concrete for anchorage as recommended by the fence manufacturer. Adjust hardware for smooth operation and lubricated where necessary.

B. Gates and gateposts shall be installed in accordance with ASTM F567 and manufacturer's recommendations.

C. Gates shall be plumb in the closed position having a bottom clearance of 3-in.

D. The opening space between the hinge or latch from the gate frame shall not exceed 3-in in the closed position.

E. Direction of swing for double swing gates shall be outward.

F. Gate stops for double gates shall be set in a concrete footing, with minimum 6-in diameter and 24-in deep.

3.04 GROUNDING

A. Fences crossed by powerlines of 600 volts or more shall be grounded at or near the point of crossing and at distances not exceeding 150 ft on each side of the crossing.

B. Ground conductor shall consist of No. 8 AWG solid copper wire. Grounding electrodes shall be ¾-in by 10 ft long copper-clad steel rod. Electrodes shall be driven into the earth so that the top of the electrode is at least 6-in below grade.

END OF SECTION

SECTION 32 90 00 – PLANTING

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. The Contractor shall provide landscaping and temporary irrigation system and appurtenant work, complete and in place, in accordance with the Contract Documents.

1.02 DEFINITIONS

A. The terms "plant material" or "plants" refer to all vegetation, whether trees, shrubs, ground cover, or herbaceous vegetation.

B. "Quality" refers to structure and form, as evidenced by density and number of canes and branches, compactness, symmetry, and general development without consideration of size or condition. "Standard quality" indicates the least acceptable quality. "Standard quality" plants shall be typical of the species and variety of good average uniform growth, shall be well formed and uniformly branched, and shall have the minimum number of canes indicated, free from irregularities, or shall conform to minimum quality index. Where the number of canes is not specifically stated in describing this grade, the "Horticultural Standards" as adopted by the American Association of Nurserymen shall apply. In such a case, the number of canes and other factors for the appropriate classification under "quality definition" in the Horticultural Standards shall be the Quality Index. Plant material below this standard will be considered "culls" and are not acceptable. Plants shall be nursery grown.

C. "Specimen" means an exceptionally heavy, symmetrical, tightly-knit plant, so trained or favored in its development and appearance as to be outstanding, superior in form, number of branches, compactness, and symmetry.

D. "Size" is the factor controlled by dimensions representing height or spread, or both, without consideration of quality or conditions. For standard quality, a dimension is given for height or container size, or a dimension is given for height as well as container size.

E. "Height" is usually indicated with a tolerance. The smaller dimension is the minimum acceptable. The larger dimension represents the maximum permissible. The average dimension of all plants shall equal the average of the tolerance figures for each item.

F. "Condition" is the factor controlled by vitality and ability to survive and thrive and be comparable with normal plants of the same species and variety in the vicinity at the same season of the year. Plants shall be free from physical damage or adverse conditions that would prevent thriving. "Condition" also sometimes refers to state of growth, i.e., whether "dormant condition" or "growing condition" and this state shall be comparable to plants of similar species in the vicinity for leaves, formation of buds, and the like.

G. "Cane" means a primary stem which starts from the ground, or close to the ground, at a point not higher than ¼ the height of the plant.

H. "Caliper" shall be measured 48-in above the finish grade or ground, as a guide, or where the trunk appears to form the head of the tree.

I. "Foliage line" is maximum dimension in case of specimen plants. It measures from ground to lowest part of body of plant.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 77 00	Project Closeout
31 10 00	Site Preparation
31 30 00	Earthwork

C. Reference Standards

ASTM International (ASTM)	
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D422	Method for Particle-Size Analysis of Soils
ASTM D4972	Standard Test Method for pH of Soils
ASTM F1647	Total Organic Matter, loss on ignition method (dry wt.)
ASTM F1815-06	Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Athletic Field Root Zones
American National Standards Institute (ANSI)	
ANSI Z60.1	American Standard for Nursery Stock, Current Edition

1.04 CONTRACTOR SUBMITTALS

A. General: Submittals shall be furnished in accordance with Section 01 33 00– Submittal Procedures.

B. Product Information

1. Manufacturer's product information on fertilizer, peat moss, mulch, seed mixtures, sod, and tree paint.

2. Topsoil Analysis Report: A report certified by an analytical laboratory which shows results of analyzing representative samples of topsoil proposed for use. Approval of the report does not constitute final acceptance of the topsoil.

C. Certificate

1. Certificates shall accompany each delivery stating source, quantity, and type of material. All certificates shall be submitted at the time of delivery.

2. Certificates of inspection of plant material, as may be required by Federal, State, or other authorities having jurisdiction, which accompany the shipment, shall be submitted at delivery.

3. Landscaping Subcontractor guarantees to perform planting maintenance services during the one-year correction of defects period.

D. Samples

1. Three samples of typical plants from each variety and size indicated shall be submitted. If approved, samples shall be planted and maintained as standards for comparison with plants provided.

2. Samples of grass seed: 1-lb samples of each type of grass seed required with the dealer's guaranteed germination rate. Grass seed shall not be delivered to the Site prior to written approval of the samples. Approval of the samples, however, shall not affect the right of the Engineer to reject the seed upon or after delivery.

3. Samples of topsoil, and top-dressing mulch, erosion control matting,.

1.05 TOPSOIL MATERIAL TESTING AND REPORTS

A. Contractor shall submit topsoil mix design samples along with topsoil analysis reports at least 30 calendar days before the start of production blending. The reports shall be certified by an analytical laboratory which provides the material properties of a minimum of three samples of the topsoil mix design which meet the requirements of these specifications, see PART 2 Materials. The mix will be subject to rejection for failure to meet the mixture’s consistency and characteristics or properties as stated in PART 2 Materials.

B. The Contractor shall provide test data reports for representative samples of the imported Topsoil used in the Work. Testing reports shall include name of product, source of individual components and testing results for each 1000 CY of blended imported topsoil and shall include the following tests:

1. Particle size distribution for individual components of a blended topsoil (ASTM C136)

2. Particle size distribution (ASTM D422)

3. ASTM D4972 - Standard Test Method for pH of Soils

4. ASTM F1815-06 - Standard Test Methods for Saturated Hydraulic Conductivity, Water Retention, Porosity, and Bulk Density of Athletic Field Root Zones

5. Nutrient Analysis Reports as described in the Quality Assurance Section of this specification.

6. Solvita maturity test for compost

7. Testing reports shall be submitted a minimum of 48 hours prior to delivery of lightweight soil media.

8. Additional Topsoil verification testing of the blended mix samples submitted by the Contractor will be done by a testing laboratory of the Owner's choice and at the Owner's expense. The Contractor shall also supply samples for testing of the individual components of the lightweight soil media materials used in the Work.

C. Maintenance Plan

1. The Contractor shall provide a Maintenance Work Plan at least 30 calendar days prior to delivery of plant materials. The work plan shall describe the methods to be employed for maintenance of plant materials prior to installation and during the maintenance period. The Maintenance Work Plan shall also describe monitoring methods, frequency of watering using the contractor designed temporary irrigation system and provisions for using supplemental hand watering. The Maintenance Work Plan shall include separate sections describing Maintenance prior to final acceptance and after final acceptance.

1.06 QUALITY ASSURANCE

A. General: All plants shall be true to type or name as indicated in the Contract Documents and shall be tagged in accordance with the standard practice recommended by the authority having jurisdiction however, determination of plant species or variety will be made by the Engineer.

B. All plants shall comply with Federal and State laws requiring inspection for plant diseases and infestations.

C. The Contractor shall obtain clearance from the County Agricultural Commissioner, as required by law, before planting plants delivered from outside the County in which they are to be planted. Evidence that such clearance has been obtained shall be filed with the Engineer.

D. Inspections will be made by the Engineer or its representative. The Contractor shall request inspection at least 24 hours in advance of the time inspection is required. Inspection is required on the following stages of the Work:

1. During preliminary grading, soil preparation, and initial weeding.

2. When trees are spotted for planting, but before planting holes have been excavated.

3. When finish grading has been completed.

4. When all Work except the maintenance period has been completed.

5. Final inspection at the completion of the maintenance period.

E. Plants shall be subject to inspection and approval or rejection by the Engineer at place of growth and upon delivery to the Site at any time before or during progress of the Work based on:

1. Quantity, quality, size, and variety;

2. Ball and root condition; and

3. Latent defects and injuries resulting from handling, disease, and insects.

F. Plants approved at pre-planting inspection are subject to rejection during planting if found to be defective.

G. Rejected plants shall be identified as such in an obvious manner, shall be removed from the Site, and be replaced with acceptable plants.

H. Plants shall have been grown in nurseries that have been inspected by the governing authorities. Inspection of plant materials required by City, County, State, or Federal authorities shall be the responsibility of the Contractor, who shall have secured permits or certificates prior to delivery of plants to Site.

I. Topsoil Mixer and Supplier: The work of this section shall be performed by a soil mixer and supplier that specializes in the custom mixing of topsoil. Provide letter of certification of a minimum of 5 years' experience of custom mixing of topsoil.

J. Topsoil Nutrient Analysis Reports: Provide a report certified by an analytical laboratory which shows results of analyzing representative samples of the Topsoil and recommendations to correct soil nutrient or micronutrient deficiencies for the following properties.

1. pH

2. Nutrients (ppm): Nitrogen (N), Phosphorus (P), Potassium (K)

3. (ppm/lb/acre): Magnesium (Mg), (SO4). Sulfur. calcium

K. Laboratory Tests as described in TOPSOIL MATERIAL TESTING AND REPORTS section shall be conducted by an independent American Association for Laboratory Accreditation (A2LA) certified laboratory with the experience and capability to conduct the tests indicated.

1.07 CLEANUP

A. Upon completion of all planting operations, the portion of the Site used for a work or storage area by the Contractor shall be cleaned of all debris, superfluous materials, and equipment. All such materials and equipment shall be entirely removed from the Site in accordance with Section 01 77 00- Project Closeout.

B. All walks or pavement shall be swept or washed clean upon completion of the Work of this Section.

C. During the entire Contract period, plant containers that have been cut or removed from plant materials shall be removed from the Site daily.

1.08 MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT

A. General: The Contractor shall be responsible for protecting, watering, and maintaining all planting and temporary irrigation systems until final acceptance of all Work under the Contract.

B. At time of acceptance of the complete project, the seeded areas shall be totally established with no bare spots, have been mowed a minimum of 4 times, and the grass shall be at least 1-¼-in to 2-in in height.

C. Watering: Trees and shrubs shall be thoroughly soaked after planting and provided with additional water at intervals as necessary to provide for good health and growth of the planting.

D. Upon completion of seeding, the entire area shall be soaked to saturation by a fine spray. Care shall be taken to avoid excessive washing or puddling on the surface and any such damage caused thereby shall be repaired.

E. Protection: The Contractor shall provide adequate protection to all newly seeded areas including the installation of approved temporary fences to prevent trespassing and damage, as well as erosion control, until the end of the correction of defects period.

F. The Contractor shall replace any materials or equipment or which its employees or Subcontractors have damaged.

G. Partial utilization of the project shall not relieve the Contractor of any of the requirements contained in the Contract Documents.

H. Mowing of seeded Areas: Mow seeded areas to maintain vegetation height 8-inches and lower in accordance with the maintenance work plan.

I. All seeded shall be fertilized every 3 weeks with 6 lb of 16-16-8 commercial fertilizer per 1000 sq ft for the first 7 weeks and be fertilized thereafter once each 5 months prior to acceptance.

J. Plants shall be maintained in a vigorous, thriving condition by watering, cultivating, weeding, pruning, spraying, and other operations necessary. No trees or shrubs will be accepted unless they are healthy and show satisfactory foliage conditions.

K. All planted areas shall be cultivated by racking at least every 2 weeks and be raked smooth to present a neat appearance, and additional mulch shall be added where necessary.

L. Maintenance shall include, in addition to the foregoing, cleaning, edging, repairs to stakes, wire, and wrappings, the repair of erosion, and all other necessary work of maintenance. Sidewalks and other paved areas shall be kept clean while planting and maintenance are in progress.

1.09 FINAL INSPECTION AND GUARANTEE

A. Inspection of seeded areas and planting will be part of final inspection under the Contract.

B. Written notice requesting inspection shall be submitted to the Engineer at least 10 days prior to the anticipated inspection date.

C. Final acceptance prior to start of the guarantee period of the Contract will be on written approval by the Engineer, on the satisfactory completion of all Work, including maintenance, but exclusive of the replacement of plant material.

D. Any delay in the completion of any item of work in the planting operation which extends the planting into more than one season shall extend the correction period in accordance with the date of completion given above.

E. The Contractor shall replace, as soon as weather conditions permit, all dead plants and all plants not in a vigorous, thriving condition which are noted at the end of the one-year correction period.

F. Plants used for replacement shall be of the same size and variety on the Plant List. Replacement plants shall be furnished, planted, staked, and mulched as indicated for new plants.

G. All Work under this Section shall be left in good order to the satisfaction of the Owner and the Engineer, and the Contractor shall, without additional expense to the Owner, replace any trees, shrubs, etc., which develop defects or die during the one-year correction period.

1.10 MAINTENANCE AND GUARANTEE FOLLOWING ACCEPTANCE OF PROJECT

A. General: The Contractor shall be responsible for a period of one year after date of acceptance of the Work of this Section, for maintaining all plantings, including all necessary plant or tree replacements, weeding, cultivating, fertilizing, pruning, controlling insects and diseases, re-guying, and performing all other operations incident thereto. The Contractor shall obtain a written guarantee from the landscaping Subcontractor embodying the provisions of this paragraph.

B. The Work covered by the maintenance and guarantee portions of this paragraph includes providing all replacements of plants, labor, materials, equipment, and supplies and in performing all operations in connection with maintenance and guarantees.

C. The inspection of seeded areas is independent of the final inspection and maintenance period. After the seeded areas have been accepted and mowed in accordance with the maintenance plan, The responsibility for mowing and irrigation will be turned over to the Owner. However, the weeding, fertilizing, and controlling of diseases of the seeded areas shall remain the responsibility of the Contractor for the remainder of the one-year maintenance and correction period.

D. All plant materials shall be in a condition acceptable to the Owner or its representative at the end of the maintenance guarantee period.

E. The Owner will furnish all water required during the maintenance and correction period.

F. Maintenance: Watering and mowing of the seeded areas during the maintenance and correction period will be performed by the Owner in accordance with written instructions which shall be furnished by the Contractor.

G. The Contractor shall replace any dead or diseased plants during the maintenance and correction period.

H. All seeded areas and planting areas shall be fertilized during the maintenance and correction period with 16-6-4 chemical fertilizer. Amount of fertilizer applied shall be per fertilizer's written instructions on bag. Fertilizers applied to planting areas shall be cultivated into the top 2-in of topsoil.

I. The Contractor shall clean-up and remove unused or waste materials from the Site and leave the area in a neat condition satisfactory to the Owner whenever it performs work during the maintenance period.

J. Final Inspection: The Owner and Contractor shall make a final inspection at the end of the one-year correction period. Any plants and materials found defective at time of final inspection shall be replaced within a time agreed upon by both parties. If it is too late in the planting season for replanting, the replacements shall be made during the next planting season even though such planting may run beyond the maintenance and correction period.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All landscaping materials for soil conditioning, weed abatement, or planting shall be first-grade, commercial quality and shall have certificates indicating the source of material, analysis, quantity, or weight attached to each sack or container or furnished with each delivery. Delivery certificates shall be given to the Engineer as each shipment of material is delivered. A list of the materials used, together with typical certificates of each material, shall be submitted to the Engineer prior to final acceptance.

2.02 TOPSOIL

A. Topsoil shall be obtained from a Topsoil Mixer and Supplier facility and shall be fertile, friable loam suitable for plant growth. Topsoil shall be subject to inspection and approval at the source of supply and upon delivery.

B. The topsoil shall be of uniform quality, free from subsoil, stiff or lumpy clay, hard clods, hardpan, rocks, disintegrated debris, plants, roots, seeds, and any other materials that would be toxic or harmful to plant growth. Topsoil shall contain no noxious weeds or noxious weed seeds.

C. The topsoil shall contain at least 6 percent organic matter as determined by loss of weight after ignition of moisture-free samples in accordance with current methods of the Association of Official Agricultural Chemists.

D. The acidity of the topsoil shall result in soil pH between 5.5 and 7.5. The salinity level shall be less than 3 millimhos/cm.

E. Clay, as determined by the Bouyoucous hydrometer or by the decantation method, shall not exceed 60 percent of the topsoil material.

F. Mechanical analysis shall be performed and shall conform to ASTM D422.

G.

2.03 FERTILIZER AND ADDITIVES

A. Fertilizer shall be furnished in bags or other standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon.

B. Chemical fertilizers shall be a free-flowing factory-mixed commercial fertilizer with percentages of nitrogen, phosphoric acid, and potash at 16-16-4 Fertilizers shall be uniform in composition, dry, and free flowing.

C. Animal fertilizer shall be well-rotted cattle manure, free from sawdust, shaving, or refuse of any kind, and shall contain no more than 25 percent straw by volume.

D. Tablets shall be 12 grams each 20-10-5 "Agriform," or equal.

E. Lime shall be dolomite limestone containing not less than 85 percent of total carbonates. Limestone shall be ground to such fineness that 100 percent will pass a No. 200 sieve.

F. Agricultural gypsum shall be standard brand agricultural calcium sulfate intended for soil application and shall contain 19 percent combined sulfur.

2.04 MULCH

A. "Silva-fiber" mulch material as the mulch component in hydroseeding mixtures shall be "Silva-fiber" as manufactured by the Weyerhauser Company, Silva Products Department, Tacoma, Washington, or equal Wood chip mulch for top dressing in planting beds shall be as shown on the plans placed to a depth of 3-inches.

B. Bark or wood chip mulch shall be derived from fir, pine, or hemlock species. It shall not contain resin, tannin, or other compounds in quantities that would be detrimental to plant life. Sawdust shall not be used as mulch. Mulch produced from finished wood products or construction debris will not be allowed.

2.05 COMPOST

A. Compost shall be derived from green material consisting of chipped, shredded, or ground vegetation or clean, processed, recycled wood products or a Class A, exceptional quality biosolids composts, as required by the United States Environmental Protection Agency (EPA), 40 CFR, Part 503c regulations or a combination of green material and biosolids compost. The compost shall be processed or completed to reduce weed seeds, pathogens, and deleterious material, and shall not contain paint, petroleum products, herbicides, fungicides, or other chemical residues that would be harmful to plant or animal life. Other deleterious material, plastic, glass, metal, or rocks shall not exceed 0.1 percent by weight or volume.

B. Additional Requirements

1. The carbon to nitrogen ratio of the compost shall be below 25:1.

2. The compost shall have an organic matter content of 35 percent to 65 percent as determined by “loss on ignition” test method.

C. Compost shall be supplied by a State approved facility.

D. Submit one-gallon sample, source, and letter of certification from the supplier to the Engineer for approval prior to installation.

2.06 PLANT MATERIALS

A. Plants shall meet requirements of the Contract Documents and shall be in accordance with the botanical names and applicable standards of quality, size, condition, and type. Plants shall be true to name, genus, species, and variety in accordance with reference publications.

B. Plant names are defined in "Standardized Plant Names" and "Bailey's Encyclopedia of Horticulture." or in The Jepson Manual: Vascular Plants of California, Second Edition (2012). When a name is not found in either reference, the accepted name used in the nursery trade shall apply.

C. Plants shall be marked for identification. Each bundle of plants and at least 25 percent of each species and variety of separate plants in any one shipment shall have legible labels securely attached before delivery to the Site.

D. Trees and shrubs shall be measured while their branches are in their normal position. Height and spread dimensions refer to the main body of the plant and not from branch or root tip to tip. No trees will be accepted with leaders cut or so damaged that cutting is necessary.

E. All plants shall be symmetrical and shall conform to the size, age, and condition on the Plant List. Exceptions are as follows:

1. Plants larger than indicated on the plant list may be used if approved by the Engineer, but approval of such plants shall not increase the Contract Price. If the use of larger plants is approved, the spread of roots or ball earth shall be increased in proportion to the size of the plant. Bare root plants furnished in size greater than indicated shall be balled and burlapped when required by the Engineer.

2. Where caliper or other dimensions of any plant materials are omitted from the Plant List, it shall be understood that such plant materials shall be normal stock for type listed.

F. Plants shall be of sound health, vigorous, and free from plant disease and shall be well branched, shall have full foliage when in leaf, and shall have a healthy well-developed normal root system. Cold storage plants will not be accepted. Plants that are sensitive to shock from elevation change shall be grown for at least 2 years at elevations close enough to the Site to alleviate any plant damage due to such change.

G. Balled and burlapped (BB) plants shall have firm, natural balls of earth of diameter not less than that indicated and be of sufficient depth to include all the fibrous and feeding roots. No plant moved with a ball will be accepted if the ball is cracked or broken before or during plant operations, except on approval of the Engineer.

H. Roots or balls of all plants shall be adequately protected at all times from sun and drying winds.

I. Plants indicated to be in marked cans, pots, or other containers on the Plant List shall have been grown in the containers for a minimum of 6 months and a maximum of 2 years. Roots shall fill the containers but show no evidence of being or having been root bound.

J. Trees shall have straight trunks and all old abrasions and cuts shall be completely callused over. In no case shall trees be topped before delivery.

K. Plants shall have been transplanted or root-pruned at least once in the 2 years prior to delivery, but plants shall not be pruned immediately prior to delivery except as authorized by the Engineer.

2.07 SEED MIXTURES

A. Seed shall conform to applicable City, County, State, and Federal regulations. Seed shall be mixed by dealer. The Contractor shall furnish dealer's guaranteed germination figure for each variety. Grass seed shall not be delivered until samples have been approved in writing by the Engineer or its authorized landscape representative. Approval of samples, however, shall not affect the right of the Engineer or the authorized landscape representative to reject seed upon or after delivery. Seed that has become wet, moldy, or otherwise damaged prior to use will not be accepted.

B. Grass seed shall be fresh, clean, new-crop seed, composed of the following varieties mixed in the proportions by weight. Purity and germination percentage shall be the results of testing.

C. Certification: Must be “Certified” grade or better per Washington State Department of Agriculture’s Rules for Seed Certification.

D. Labeling: Each container must include:

1. Common and botanical names

2. Lot number

3. Net weight

4. Pure Live Seed (PLS) percentage

5. Vendor Licensing:

6. Must have a Washington State business license with a “seed dealer” endorsement.

E. Seed must be dry, undamaged, and free from mold.

F. Wet or moldy seed will be rejected.

G. Seed mixes shall be as follows:

1. Erosion Control Mix / Sludge Pond:

Common Name	Botanical Name	% by Weight

Red Fescue	*Festuca rubra*	30%
Perennial Ryegrass	*Lolium perenne*	25%
Colonial Bentgrass	*Agrostis tenuis*	15%
Hard Fescue	*Festuca trachyphylla*	10%
White Clover	*Trifolium repens*	10%
Annual Ryegrass	*Lolium multiflorum*	10%

Erosion Control Mix / Sludge Pond Application Rate: 80lb/Acre.

2. Drought Tolerant Meadow Seed Mix shall be 60% Grasses and 40% Forbs and Wildflowers as follows:

   Grasses – 60%

Common Name	**Botanical Name**	**% by Weight**
Roemer's Fescue	Festuca roemeri	25%
Idaho Fescue	Festuca idahoensis	20%
California Oatgrass	Danthonia californica	15%

Forbs and Wildflower – 40%

Common Name	**Botanical Name**	**% by Weight**
Yarrow	Achillea millefolium	10%
Oregon Sunshine	Eriophyllum lanatum	10%
Western Pearly Everlasting	Anaphalis margaritacea	10%
Lupine (various spp.)	Lupinus spp.	5%
Clarkia	Clarkia amoena	5%

Drought Tolerant Meadow Seed Mix Application Rate: 30lb/Acre.

2.08 STAKING MATERIALS

A. Staking materials as shown on details.

2.09 EROSION CONTROL MATTING

1. Organic temporary erosion control blanket shall meet the following requirements:

2. Made of natural plant fibers.

3. Have a minimum weight of 8 oz/sq yd and a minimum limiting shear stress of 0.45 lb/sq ft .

PART 3 -- EXECUTION

3.01 GENERAL

A. The landscape work shall not be performed at any time when it may be subject to damage by climatic conditions.

B. The Contractor shall carefully scale or otherwise verify all dimensions in the Contract Documents. Dimensions and plant locations shall be coordinated with Engineer and final location shall be Site-oriented by the planter and Engineer. Any discrepancies or inconsistencies shall be brought to the attention of the Engineer.

C. In case of conflict between the Plant List totals and total plant count of the Contract Documents, the Contractor shall provide the higher number of plants.

D. Delivery of materials may begin only after samples and tests have been approved by the Engineer. Materials provided shall be not less quality than the approved sample.

E. Substitutions for the indicated plant materials may be considered pursuant to the Contract Documents.

F. The Contractor shall provide temporary fencing, barricades, covering, or other protections to preserve existing landscaping items indicated to remain and to protect the adjacent properties and other structures when they may be damaged by the landscape work.

G. The Contractor shall retain the services of a tree surgeon approved by the Engineer to repair damage to existing trees. Existing trees which are to be saved and which cannot be restored to full growth, as determined by tree surgeon, shall be removed and replaced with a new similar tree of 24-in box size unless otherwise approved by the Engineer.

H. The Contractor shall remove and/or relocate landscape items such as trees, shrubs, grass, other vegetation, improvements, and obstructions as indicated.

I. Waste materials shall be removed and disposed of off the Site, unless otherwise indicated.

J. It shall be the responsibility of the Contractor to obtain information regarding utilities in the area of work and to prevent damage to the same. The Contractor shall protect the utilities as necessary.

K. Burning of combustible materials on the Site shall not be permitted.

L. The Contractor shall protect structures, sidewalks, pavements, and other facilities that are subject to damage during landscape work. Open excavations shall be provided with barricades and warning lights which conform to the requirements of governing authorities and the State's OSHA safety requirements from dusk to dawn each day and when needed for safety.

M. Planting areas include all areas to be landscaped unless indicated otherwise.

3.02 SOIL PREPARATION

A. The landscape work shall not begin until all other trades have repaired all areas of settlement, erosion, rutting, etc., and the soils have been re-established, recompacted, and refinished to finish grades. The Engineer shall be notified of all areas that prevent the landscape work from being executed.

B. Areas requiring grading by the landscaper including adjacent transition areas shall be uniformly level or sloping between finish elevations to within 0.10 ft above or below required finish elevations.

C. The landscape work shall not proceed until after walks, curbs, pavings, edging, and irrigation systems are in place. Work under the Contract shall be completed to a point where the landscape areas will not be disturbed. The subgrade shall be free of waste materials of all kinds.

D. During grading, waste materials in the planting areas such as weeds, rocks 2-in and larger, building materials, rubble, wires, cans, glass, lumber, sticks, etc., shall be removed from the Site. Weeds shall be dug out by the roots.

E. Fertilizers, additives, seed, peat, etc. subject to moisture damage shall be kept dry in a weatherproof storage place.

F. After removal of waste materials, the planting area subgrade shall be scarified and pulverized to a depth of not less than 6-in and all surface irregularities below the cover of topsoil shall be removed.

G. Soil Preparation and Finish grading shall consist of:

1. Remove waste materials and weeds from prepared subgrade.

    a. After grading and establishment of subgrade, waste materials in the planting areas such as weeds, rocks 2-in and larger, building materials, rubble, wires, cans, plastic, glass, lumber, sticks, etc., shall be removed from the Site. Weeds shall be dug out by the roots.

2. Final contouring of the planting areas.

3. Placing the depth of specified Topsoil and/or Compost.

4. Placing all soil additives and fertilizers.

5. Tilling of planting areas to a depth of 8-in thoroughly incorporating compost into subgrade

6. After tilling, bring areas to uniform grades by floating and/or hand raking.

7. Making minor adjustment of finish grades as directed by the Engineer.

8. Removing waste materials such as stones, roots, or other undesirable foreign material larger than 1-in in diameter and raking, disking, dragging, and smoothing soil ready for planting.

H. Any unusual subsoil condition that will require special treatment shall be reported to the Engineer.

I. Compost shall be uniformly distributed over all areas where required. Subgrade and topsoil shall be damp and free from frost.

J. Surface drainage shall be provided as indicated by shaping the surfaces to facilitate the natural run-off of water. Low spots and pockets shall be filled with topsoil and graded to drain properly.

K. Finish grade of all planting areas shall be 1-½-in below finish grade of adjacent pavement of any kind.

3.03 COMPOST PLACEMENT

A. Compost shall be placed and incorporated into subgrade as indicated in the table below

Planting Area	**Topsoil Depth**	**Compost Depth**	**Soil Preparation Required Per Paragraph "SOIL PREPARATION"**
Planting Areas	0-in	3-in	Yes
Stormwater or Bioswale Facility	12-in	0-in	Yes
Seeded Areas	0-in	3-in	Yes
Long Term Stockpile Erosion Control Seeding	0-in	1-in	No
Erosion Control Seeding Areas	0-in	0-in	No

3.04 DELIVERY, STORAGE, AND HANDLING OF PLANT MATERIALS

A. No plants other than the required samples shall be dug or delivered to the Site until the required inspections have been made and the plant samples are approved.

B. Plants shall not be pruned prior to delivery except upon approval by the Engineer.

C. Plant material shall be planted on the day of delivery if possible. The Contractor shall protect the stock in a temporary nursery at the Site where it shall be protected from sun and drying winds and shall be shaded, kept moist, and protected with damp soil, moss, or other acceptable material. Plants shall be planted within 2 days after delivery.

D. All balled and burlapped plants which cannot be planted immediately after delivery shall be set on the ground and be well protected with soil, wet moss, or other acceptable material. Bare rooted plants, which cannot be planted immediately, shall be planted in heeled-in trenches immediately upon delivery. No material heeled-in for more than one week may be used. Bundles of plants shall be opened and the plants separated before the roots are covered. Care shall be taken to prevent air pockets among the roots.

E. During planting operations, bare roots shall be covered with canvas, wet straw, or other suitable materials. No plants shall be bound with wire or rope at any time so as to damage the bark or break branches.

F. Plants shall not be picked up or moved by stem or branches but shall be lifted and handled from the sides of the containers.

G. Plants shall be lifted and handled from the bottom of the ball or container. Plants with balls cracked or broken before or during planting operations will not be accepted and shall be immediately removed from the Site.

3.05 TREE AND PLANT LOCATIONS

A. The Contractor shall locate and stake all tree and shrub locations and have the locations approved by the Engineer before starting excavation for same. The plant locations shall be observed, and their locations shall be adjusted as directed by Engineer before final approval.

B. No trees shall be located closer than 72-in to structures unless otherwise indicated. Ground covers and shrubs may be planted up to structures or curbs.

3.06 PLANT PITS

A. Plant pits, centered on location stakes, shall be excavated circular pits with vertical sides and flat or saucer shape bottom in accordance with the following sizes unless indicated otherwise:

1. Tree pits shall be at as shown on planting details.

2. Shrubs pits shall be at as shown on planting details.

3.07 PREPARED BACKFILL

A. Tree and shrub pit backfilling soil shall consist of 3 parts topsoil, and 1 compost by volume. Commercial fertilizer shall be sparingly mixed with the prepared topsoil, using 5 lb/cu yd or as required by manufacturer's printed recommendations.

B. Materials shall be thoroughly rotary-mixed on the Site before placement. Mixing of materials in pits, bins, trenches or beds will not be permitted.

C. Tree and shrub pits shall be provided with fertilizer tablets as follows:

1. 1 per one-gallon can plant

2. 3 per 5-gallon can plant

3. 5 per 15-gallon can plant

3.08 ROCKS OR UNDERGROUND OBSTRUCTIONS

A. In the event that rock or underground obstructions are encountered in the excavation of plant pits, alternative locations will be selected by the Engineer. Moving of trees to alternative locations shall not entail additional costs to the Owner.

3.09 SETTING PLANT MATERIALS

A. The soil shall not be worked when the moisture content is so great that excessive compaction will occur, nor when it is so dry that a dust will form in the air or that clods will not break readily. Water shall be applied if necessary to provide ideal moisture for filling and for planting.

B. Plants shall be set plumb and straight in center of pits, and bear the same relation to finish grade as it bore to previous planting.

C. Balled and burlapped trees shall have planting soil placed and compacted around base of ball to fill all voids. All burlap ropes or wires shall be removed from the sides and tops of balls.

D. Roots of bare root plants shall be properly spread out and planting soil carefully worked in among them. All broken or frayed roots shall be cut off clean.

E. Ground cover plants shall be evenly spaced, staggered in rows, and set at intervals indicated, so as to produce a uniform effect. Plants shall be watered immediately after planting operations have been completed.

F. Shrubs shall be pruned to remove damaged branches..

G. Planting soil around roots or balls shall be thoroughly compacted and watered. After planting, the soil in the shrub beds shall be cultivated between shrubs, raked smooth, and neatly outlined. Muddy soil shall not be used for backfilling. All broken or frayed roots shall be properly cut off.

H. Trees shall be thoroughly watered immediately after planting.

I. Remove all tags and labels when directed by Engineer.

3.10 STAKING

A. Staking of trees shall be done immediately after planting. Plants shall stand plumb after staking. Staking shall be as indicated.

B. Tree Staking shall be as detailed on the plans.

3.11 PRUNING AND MULCHING

A. Each tree and shrub shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant in the manner fitting its use in the landscape design, as approved by the Engineer.

B. All dead wood or suckers and all broken or badly bruised branches shall be removed by thinning out and shortening branches. Deciduous bare-rooted plants shall have not less than 1/3 of their respective leaf surfaces removed. All cuts shall be made just above a healthy bud. Pruning shall be done with clean, sharp tools.

C. Plants shall be mulched after planting and cultivating have been completed. A layer of Top Dressing Mulch materials shall be spread on finished landscaping grade within all planting areas to a depth of 3-in The mulch around isolated plants shall be 6-in greater in diameter than the planting hole. All shrub and ground cover beds shall be completely covered with the mulch.

3.12 SEEDING-GENERAL

A. Grass seeds shall be provided where seeding is indicated and shall be maintained according to paragraph MAINTENANCE OF LANDSCAPING PLANTING PRIOR TO ACCEPTANCE OF PROJECT above.

B. The soil shall be prepared and fertilized before seeding or shall be prepared per hydroseeding instructions. The Contractor shall prepare only enough ground that can be planted within 24 hours thereafter.

C. Soil preparation shall consist of the following:

1. Preparation of sub-grade grading shall be per paragraphs entitled GENERAL and SOIL PREPARATION, respectively, above.

2. Finish grading of soil per paragraph entitled SOIL PREPARATION, above.

D. Seed application rates shall be as shown in the seed mix tables and shall conform to one of the following methods listed below.

3.13 BROADCAST SEEDING

A. Do not commence seeding operation until all requirements of paragraph SEEDING – GENERAL have been approved by the Engineer.

B. Sow seed at the rate as shown on the seed mix table. Equal quantities of seed shall be sown in the directions at right angles to each other to produce an even distribution of seed over the entire area.

C. No seeding shall be done when wind velocity exceeds 4 mph, within 24 hours after rain, or if the surface has been compacted without first loosening the ground.

D. All seeded areas shall be covered with sphagnum peat moss or clean straw uniformly at a rate of 1 ½ standard bales per 1000 sq ft

E. All seeded slopes greater than 5 percent, or places where erosion is a problem, shall be mulched with straw at a rate of 2 bales per 1000 sq ft or with approved erosion control matting.

F. This seeding method may be utilized between March 15 and October 15.

3.14 HYDROSEEDING

A. Do not commence seeding operation until all requirements of paragraph SEEDING – GENERAL have been approved by the Engineer.

B. One-step hydroseeding may be utilized between May 1 and September 15.This method consists of preparing the seed bed; combining seed and fertilizer mixture at the specified rates and mix "Silva-fiber" or equal at the rate of 1400 lb per acre of area into water in tanks; agitating these compounds into a well-mixed slurry suspension; and spraying the mixture under pressure onto the prepared areas to be seeded.

END OF SECTION

SECTION 33 05 05 – PRESSURE PIPE TESTING AND DISINFECTION

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall test and disinfect potable water pipelines and appurtenant piping, in accordance with the Contract Documents.

B. The Contractor shall be responsible for obtaining permits for discharging excess testing and disinfection water and dechlorination of such water if required to satisfy permit limits.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Definitions

1. Makeup water: The quantity of water that must be supplied into a pipeline section to maintain the specified test pressure during a hydrostatic pressure test.

2. Pigging: Passage of a sufficient number of pigs through a pipeline to achieve the clean conditions required.

3. Testing allowance: The maximum quantity of makeup water that may be added into a pipeline section undergoing hydrostatic pressure testing to maintain the specified test pressure.

4. Visible Leakage: The visible escape (e.g., drip, spray, stream, flow) of test liquid from the test section through components, joints, connections, appurtenances, and the like in the test section.

C. Reference Specifications

01 33 00	Submittal Procedures

D. Reference Standards

American National Standards Institute (ANSI) / American Water Works Association (AWWA)	
ANSI/AWWA B300	Hypochlorites
ANSI/AWWA B301	Liquid Chlorine
ANSI/AWWA C600	Installation of Ductile-Iron Mains and Their Appurtenances
ANSI/AWWA C604	Installation of Buried Steel Water Pipe – 4-in and Larger
ANSI/AWWA C651	Disinfecting Water Mains
ANSI/AWWA C655	Field Dechlorination
ANSI/AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4-in. Through 60-in

AWWA Manual M9	Concrete Pressure Pipe
AWWA Manual M41	Ductile-Iron Pipe and Fittings
AWWA Manual M55	PE Pipe - Design and Installation
ASTM International (ASTM)	
ASTM F2164	Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Furnish:

1. A testing plan and schedule for flushing, and hydrostatic testing. This shall include all equipment to be used including but not limited to pump, metering device, pressure gauge, etc., to be used for maintaining test pressure and measuring the amount of water required to maintain test pressure; method of connection of pump to pipeline; sections of pipeline to be tested with length and size of pipe, the exact area being tested, and the valves, plugs, caps, etc., being tested against indicated; and allowable loss calculations.

2. A plan and schedule for disinfection and bacteriological testing. This shall include the form of chlorine to be used; method of chlorination; flushing locations, rates of flushing, and locations of drainage facilities; the number and frequency of samples for bacteriological tests; method of taking samples; and name of the certified bacteriological testing laboratory.

3. Chlorine gas shall not be used.

PART 2 -- PRODUCTS

2.01 EQUIPMENT AND MATERIALS

A. All test equipment, chemicals for chlorination, temporary valves, bulkheads, and other water control equipment, and choice of disinfectant shall be as determined by the Contractor. No materials shall be used that would be injurious to the WORK for future conveyance of potable water.

B. Pressure Monitoring: A pressure gage or sensor accurate to within 2 percent of full scale, with full scale no be more than twice the test pressure and scale graduations no greater than 2 percent of the full scale.

C. Chlorine for disinfection may be in the form of sodium hypochlorite solution, or calcium hypochlorite granules or tablets.

1. Sodium hypochlorite (liquid form) and calcium hypochlorite (granular form or tablets) shall be in accordance with ANSI/AWWA B300.

D. Dechlorination agents shall be in accordance with ANSI/AWWA C655.

PART 3 -- EXECUTION

3.01 GENERAL

A. Water for testing and disinfecting water pipelines will be furnished by the Owner; however, the Contractor shall convey the water from the Owner-designated source to the points of use.

B. Hydrostatic pressure testing shall be performed for all pressure pipelines. Potable water shall be disinfected. All chlorinating and testing operations shall be performed in the presence of the Engineer.

C. Disposal of flushing water and water containing chlorine shall be by methods acceptable to the Engineer.

D. Disinfection operations shall be scheduled as late as possible during the Contract Time to maximize the degree of sterility of the facilities at the time the WORK is accepted by the Owner. Bacteriological testing shall be performed by a certified testing laboratory accepted by the Owner. Results of the bacteriological testing shall be satisfactory with the state Department of Health or other regulatory agency having jurisdiction.

3.02 FLUSHING AND PIGGING

A. Flushing is recommended prior to a pressure test to reduce the probability of foreign material causing valve-seat or hydrant-seat leakage during pressure tests. Flushing should be accomplished by partially opening and closing valves and hydrants several times under expected line pressure, with flow velocities adequate to flush foreign material out. The pipeline flow velocity shall be no less than 3.0 ft/s The duration of the initial flushing procedure shall be continued until the discharge appears clean; however, the minimum duration shall be based sufficient that a minimum of three changes of pipeline volume occurs.

B. For larger mains or where conditions do not permit the required flow to be discharge to waste, pigging shall be required. The Contractor shall clean the system thoroughly by pigging to remove sand, grit, gravel, stones, fluids, construction waste, and all material which would not be found in a properly cleaned pipeline. Pigging shall obtain a smooth interior pipe surface free from any material or fluid not used in cleaning.

1. Provision for pig access and egress points and disposal of water and materials shall be the Contractor's responsibility.

2. Pigs shall be individually marked and their location shall be controlled and monitored so that no pigs remain in the system after cleaning.

3. Pigging may be done in conjunction with initial filling for the hydrostatic test.

C. For 24-in or larger diameter mains, an acceptable alternative to flushing is to carefully broom-sweep the main, carefully removing sweepings prior to filling and chlorinating the main. The Contractor shall address OSHA requirements for confined space prior to entering a pipeline.

D. General Requirements:

1. The Contractor shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline or, where such valves are not present, the Contractor shall install temporary bulkheads or plugs for the purpose of testing. Sections that have a zero leakage allowance may be tested as a unit.

2. The Contractor shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment.

3. The Contractor shall remove or protect pipeline-mounted devices that may be damaged by the test pressure.

4. No section of the pipeline shall be tested until field-placed concrete or mortar has attained an age of 14 days.

5. Hydrostatic testing shall be conducted in accordance with this Section and requirements of the following:

    a. Ductile iron pipe: AWWA Manual M41 and ANSI/AWWA C600.

    b. PVC pipe: ANSI/AWWA C900.

E. Pre-test Procedures:

1. The test section shall be slowly filled with potable water at a rate that allows air to leave the line at the same rate as water entering the line to minimize air entrapment and potential surge pressures. The test section shall be filled from a low point.

2. Air shall be expelled completed from the test section. If permanent air vents are not located at all high points, corporation cocks shall be installed at all high points to expel any air as the line is filled with water. Following the removal of any air, the corporation cocks shall be closed and the test pressure applied.

    a. At the conclusion of the pressure test, the corporation cocks shall either be removed and the pipe plugged or be left in place as directed by the Engineer.

3. The main valve of hydrants in the test section shall be closed.

4. Pipe with cement-mortar linings shall be filled for a minimum of 24 hours prior to testing to allow for water absorption into the lining. Concrete pressure pipe shall be filled for a minimum of 48 hours prior to testing to allow concrete lining to be saturated.

5. The specified test pressure shall be applied using a suitable pump connected to the pipeline.

6. The pipeline shall be allowed to stabilize at the test pressure before conducting the hydrostatic pressure. This may require several cycles of pressurizing and bleeding trapped air prior to beginning the test.

F. Hydrostatic Pressure Testing for Acceptance:

1. The hydrostatic test shall be of at least a 2-hr duration.

2. The test pressure in the test section shall be as indicated in the Piping Schedule. The test pressure shall be measured at the lowest point of the test section.

3. The test pressure shall not vary by more than 5 psi for the duration of the test. Test pressure shall be maintained within this tolerance by adding makeup water through the pressure test pump into the pipeline to return the pressure in the test section to the starting pressure.

4. At the end of the test period, makeup water shall be added through the pressure test pump into the pipeline to return the pressure in the test section to the starting pressure.

5. The section of pipe passes if the total amount of makeup water added during the test period and at the end of the test period does not exceed the applicable testing allowance.

G. Testing Allowance:

1. For test sections up to 2,000 ft of pipe, the testing allowance shall be calculated based on the actual length of pipe.

2. If pipe with a zero leakage allowance is included in a test section, then length of pipe with a zero leakage allowance shall not be considered when calculating the testing allowance.

3. For distribution and transmission pipelines with rubber-gasketed joints, the testing allowance shall be:

   a. PVC and Ductile Iron Pipe: 10.5 gallons per nominal inch diameter per mile per 24 hours

4. Pipelines with welded or heat-fusion joints shall have no leakage.

5. Exposed piping shall have no visible leakage and no pressure loss during the test.

3.03 HYDROSTATIC TESTING OF HDPE PIPELINES

A. General Requirements

1. The Contractor shall test pipelines in sections. Sections to be tested shall be defined by isolation valves in the pipeline or, where such valves are not present, the Contractor shall install temporary bulkheads or plugs for the purpose of testing. Sections that do not have isolation valves shall be tested in approximate one-mile segments.

2. The Contractor shall be responsible for ascertaining that test bulkheads are suitably restrained to resist the thrust of the test pressure without damage to or movement of the adjacent pipe. Unharnessed sleeve-type couplings, expansion joints, or other sliding joints shall be restrained or suitably anchored prior to the test to avoid movement and damage to piping and equipment.

3. The Contractor shall remove or protect pipeline-mounted devices that may be damaged by the test pressure.

B. Pre-test Procedures

1. The test section shall be slowly filled with potable water at a rate that allows air to leave the line at the same rate as water entering the line to minimize air entrapment and potential surge pressures.

2. Air shall be expelled completed from the test section. If permanent air vents are not located at all high points, corporation cocks shall be installed at all high points to expel any air as the line is filled with water. Following the removal of any air, the corporation cocks shall be closed and the test pressure applied.

   a. At the conclusion of the pressure test, the corporation cocks shall either be removed and the pipe plugged or be left in place as directed by the Engineer.

3. The main valve of hydrants in the test section shall be closed.

C. Hydrostatic Pressure Testing for Acceptance

1. Pressurize the test section by gradually adding water using a suitable pump connected to the pipeline. Initially advance the pressure to 50 psi. Then the pressure shall be advanced in gradual additional until the test pressure is achieved. The test pressure shall be maintained for 3 hours to allow for pipe expansion, adding water as necessary.

2. Immediately after the 3-hour expansion period, the test pressure shall be reduced by 10 psi and the addition of water stopped. Monitor for 1 hour. If the pressure drops by less than 5 percent, then the test section of HPDE pipeline passes.

3.04 REPAIR AND RETESTING AFTER FAILING TESTS

A. In the case of pipelines that fail to pass the leakage test, the Contractor shall determine the cause of the leakage, shall take corrective measures necessary to repair the leaks, and shall again test the pipeline, repeating as necessary until the pipeline passes.

3.05 DISINFECTING PIPELINES

A. General: Potable water pipelines except those appurtenant to hydraulic structures shall be disinfected in accordance with the requirements of ANSI/AWWA C651 using the “Continuous-Feed Method” as modified herein. Where not practical (e.g., for large-diameter mains where the volume of water makes the continuous-feed method impractical and difficult to achieve for short segments), pipelines shall be disinfected using the “Slug Method” in accordance with ANSI/AWWA C651.

B. Chlorination: A chlorine-water mixture shall be uniformly introduced into the pipeline by means of a solution-feed chlorinating device. The chlorine solution shall be introduced at one end of the pipeline through a tap in such a manner that as the pipeline is filled with water, the dosage applied to the water entering the pipe shall be approximately 0.000417 lbs/gallon or 50 mg/L. Care shall be taken to prevent the strong chlorine solution in the line being disinfected from flowing back into the line supplying the water.

C. Retention Period: Chlorinated water shall be retained in the pipeline for at least 24 hours. After the chlorine-treated water has been retained for the required time, the free chlorine residual at the pipeline extremities and at other representative points shall be at least 0.000209 lbs/gallon or 25 mg/L. If testing does not demonstrate a residual of 0.000209 lbs/gallon or 25 mg/L or greater, the disinfection procedure above shall be repeated.

D. Chlorinating Valves: During the process of chlorinating the pipelines, valves and other appurtenances shall be operated from closed to full open to closed while the pipeline is filled with the heavily-chlorinated water.

E. Sampling Taps: The Contractor shall provide sampling taps as shown in ANSI/AWWA C651 or as approved by the Engineer. Taps may be made at manways and air valves to help facilitate the spacing requirement.

F. Final Flushing: After the applicable retention period, the heavily chlorinated water shall be flushed from the pipeline until chlorine measurements show that the concentration in the water leaving the pipeline is no higher than that generally prevailing in the system or is acceptable for domestic use. Any release of chlorinated water into the environment shall comply with applicable federal, state, and local regulations and the permit requirements for the project. Dechlorination of chlorinated water being discharged to the environment shall be performed in accordance with ANSI/AWWA C655.

G. Bacteriological Testing: After disinfection and final flushing such that typical system chlorin residuals are present, if the system operates with a residual, bacteriological testing for total coliform analysis shall be performed in accordance with ANSI/AWWA C651 and the applicable requirements of the Washington Department of Health. The pipe shall be filled with fresh potable water and left for a period of 24 hours before any sample is collected. An initial set of samples shall be taken and then second set up samples shall be taken after a minimum of 16 hours.

H. Redisinfection: If the initial disinfection treatment fails to produce satisfactory bacteriological test results, the disinfection procedure shall be repeated until acceptable results are obtained.

3.06 CONNECTIONS TO EXISTING SYSTEM

A. Where connections are to be made to an existing potable water system, the interior surfaces of all pipe and fittings used in making the connections shall be swabbed or sprayed with a minimum one percent free chlorine solution before installation. Thorough flushing shall be started as soon as the connection is completed and shall be continued until discolored water is eliminated.

END OF SECTION

SECTION 33 05 05.32 – GRAVITY PIPELINE TESTING

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall test sanitary system pipelines in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
33 05 05	Pressure Pipe Testing and Disinfection

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Furnish:

1. A testing plan and schedule including methods for water conveyance, control, leak testing, and water disposal shall be submitted in writing for approval.

PART 2 -- PRODUCTS

PART 3 -- EXECUTION

3.01 GENERAL

A. Gravity sewer pipes and service laterals shall be tested for exfiltration or infiltration as indicated. Manholes shall be tested for leakage prior to backfill placement, whereas pipes shall be backfilled prior to testing. The maximum length of pipe tested shall be the 4 reaches between 5 manholes. Leakage tests shall be completed and approved prior to placing of permanent resurfacing of pavement. When leakage or infiltration exceeds the allowed amount, the Contractor shall locate the leaks and make the necessary repairs or replacements to reduce the leakage or infiltration to the allowable limits. Individually detectable leaks shall be repaired, regardless of whether the test results are acceptable or not.

B. Unless otherwise indicated, water for testing will be furnished by the Owner; however, the Contractor shall convey the water from the Owner-designated source to the points of use.

C. No materials shall be used which would be injurious to pipeline structure and future function. Air test gauges shall be laboratory-calibrated test gauges, and if required by the Engineer, shall be recalibrated by a certified laboratory prior to the leakage test. Air test gauges shall have a size and pressure range appropriate for the pipe being tested.

D. Testing operations shall be performed in the presence of the Engineer.

3.02 TESTING SCHEDULE

A. Leakage Tests

1. Perform the type of leakage tests determined from the table below, based on pipe size, slope between manholes (Criterion 1), and difference in water levels (Criterion 2).

Nominal Pipe Size	**Criterion 1**		**Criterion 2**	
	Manhole Delta H, feet		**Test Water vs Ground Water Delta H, feet**	
	less than or equal to 10 ft	greater than 10 ft	greater than or equal to 4 ft	less than 4 ft
less than or equal to 24 -in	See Criterion 2	Infiltration or Air		
greater than 24-in	See Note 1	Exfiltration	Infiltration or Air	

Note 1. If ground water is present, perform an infiltration test or air test at the option of the Contractor; if no ground water is present, perform an air test.

2. Definitions

a. Delta H is the difference between 2 elevations.

b. Manhole Delta H is the invert elevation difference in 2 adjacent manholes.

c. Test Water vs Ground Water Delta H is the required elevation of water surface for testing minus the average elevation of ground water adjacent to the pipe to be tested.

3. For pressure sewers and forcemains, conduct water pressure tests as required by Section 33 05 05 – Pressure Pipe Testing and Disinfection.

3.03 WATER EXFILTRATION TEST

A. Each section of sewer shall be tested between successive manholes by closing the lower end and the inlet sewers of the upper manhole with stoppers or inflatable plugs. The pipe and manhole shall be filled with water to a point 4 ft above the centerline of the sewer at the center of the upper manhole; or if ground water is present, 4 ft above the average adjacent ground water level, whichever is higher.

B. Before the test begins, water shall remain in the pipe until the concrete manholes and pipe have absorbed enough water such that the water level stabilizes, or for a minimum of 4 hours, whichever is longer. The minimum test duration shall be 4 hours.

C. Unless indicated otherwise, the Contractor shall measure exfiltration. Measure the amount of water added to the upstream manhole to maintain the water level at the elevation set above. Compare the amount added to the allowable leakage calculated below, and if the amount added is equal to or less than the allowable amount, the tested section of the pipe has passed.

D. The allowable leakage will be computed by the formula:

$E = 0.000012\ LD\ (H)^{½}$ ($E = 0.000175\ LD\ (H)^{½}$)

Where:

E = Allowable leakage in gallons per minute liters per second of sewer tested.

L = Length of sewer and house connections tested, in feet meters.

D = Internal diameter of the pipe in inches metres.

H = Elevation difference in feet metres between the water surface in the upper manhole and the centerline of the pipe at the lower manhole; or if ground water is present above the centerline of the pipe in the lower manhole, the difference in elevation between the water surface in the upper manhole and the ground water at the lower manhole.

3.04 WATER INFILTRATION TEST

A. The end of the sewer at the upper structure shall be closed to prevent the entrance of water and pumping of ground water shall be discontinued for at least 3 days, after which the section shall be tested for infiltration.

B. The infiltration into each individual reach of sewer between adjoining manholes shall not exceed that allowed by the formula above, where H is the difference in the elevation between the ground water surface and the invert of the sewer at the downstream manhole.

C. Unless otherwise indicated, infiltration shall be measured by the Contractor.

3.05 AIR PRESSURE TEST

A. The Contractor shall furnish all materials, equipment, and labor for making an air test. Air test equipment shall be approved by the Engineer.

B. The Contractor may conduct an initial air test of the sewer main line after densification of the backfill but prior to installation of the service laterals. Such tests will be considered to be for the Contractor's convenience and need not be performed in the presence of the Engineer.

C. Each section of sewer shall be tested between successive manholes by plugging and bracing all openings in the pipe and the upper ends of all service laterals. Prior to insertion in the sewer, each plug shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, and the leaks eliminated, or the plug replaced.

D. The test of the pipe and service laterals shall be conducted in the presence of the Engineer. Testing of pipe, regardless of the pipe material, shall be performed in accordance with ASTM F 1417 - Standard Test Method for Installation of Plastic Gravity Sewer Line Using Low Pressure Air.

E. Air pressure in the sewer line shall be increased to 4.0 psi above groundwater pressure 1.0 psi for each 2.3 ft of water elevation above the highest point of the pipe). Do not allow the pressure at any point in the pipe to reach 9 psi under any circumstances. Allow the pressure to stabilize for 5 minutes, then reduce the pressure to 3.5 psi above groundwater pressure and start the test. Stop the air release and record the decrease in pressure over time.

F. Pass/Fail Criterion: The time taken for the pressure to decrease from 3.5 psi to 2.5 psi above groundwater pressure shall be equal to or greater than the time below.

Nominal Pipe Diameter, inches	**Minimum Time, min: sec**	**Length for Minimum Time, foot**	**Increased Time for Longer Lengths, seconds per foot**
4	3:46	597	.0380
6	5:40	398	0.854
8	7:34	298	1.520
10	9:26	239	2.374
12	11:20	199	3.418
18	17:00	133	7.692
24	22:40	99	13.674
30	28:20	80	21.366
36	34:00	66	30.768

G. Testing criteria of pipe 12-in and larger may be adjusted if the Engineer approves. The air pressure decrease may be 0.5 psi instead of 1.0 psi, and the corresponding minimum times will be one-half of the tabulated times.

H. For pipe larger than 24-in, air pressure tests may be performed on each joint. The time for the pressure to fall from 3.5 psi to 2.5 psi, both above groundwater pressure, shall not be less than 10 seconds regardless of pipe diameter.

I. If the time is less than the allowable time, the pipe will be considered defective and shall be repaired and retested.

3.06 MANHOLE TEST

A. Sewer manholes shall be hydrostatically tested for leakage prior to backfilling. Prior to testing, manholes shall be visually inspected for obvious defects. Leaks or cracks shall be repaired to the satisfaction of the Engineer.

B. Hydrostatic Testing: All pipes entering the manhole shall be sealed at a point outside the manhole walls to include testing of the pipe to manhole joints. The manhole shall be filled with water to a level 2-in below the top of the frame. Safety lines shall be secured to all plugs utilized. After a period of at least four hours to allow the water level to stabilize, the manhole shall be refilled, and the water level shall be marked. The water level shall again be checked after 4 hours. If the water level falls more than 1-in, the leakage shall be considered excessive, and the Contractor shall make repairs and retest the manhole. The exterior of the manhole shall be inspected during this period for visible evidence of leakage. Visible moisture, sweating, or beads of water on the exterior of the manhole shall not be considered leakage, but any water running across the surface will be considered leakage and shall be repaired to the satisfaction of the Engineer regardless of the volume of water lost.

END OF SECTION

SECTION 33 05 31 – POLYVINYL CHLORIDE GRAVITY SEWER PIPE

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide PVC solid wall non pressure pipe and appurtenant Work, complete and in place, in accordance with the Contract Documents.

B. This Section covers pipe from 4-in to 60-in diameter nominal size, for use in storm sewer, sanitary sewer, or other non-pressure sewer applications.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 77 00	Project Closeout
31 30 00	Earthwork Methods
33 05 05	Pressure Pipe Testing and Disinfection

C. Reference Standards

American Society for Testing and Materials (ASTM) Standards	
ASTM D1784	Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D2321	Recommended practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D3034	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F679	Polyvinyl Chloride (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
ASTM F1417	Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air
American Water Works Association (AWWA) Standard	
AWWA M23	PVC Pipe – Design and Installation
AWWA C110	Ductile-Iron and Gray-Iron Fittings
AWWA C153	Ductile-Iron Compact Fittings

1.3 CONTRACTOR SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures.

B. Certificates: The Contractor shall submit manufacturer's certificate that pipe conforms to these specifications.

1.4 QUALITY ASSURANCE

A. Testing: Materials testing shall be based upon applicable ASTM Test Methods referenced herein. Costs of such inspection and tests shall be borne by the Contractor.

B. Mandrel Test: In addition to the requirements as specified in Section 33 05 05 - Gravity Pipeline Testing, all PVC gravity sewer pipe shall be tested for deflection and obstructions.

C. Certificates: Manufacturer's notarized certificates of compliance shall be furnished by the Contractor.

D. The pipe shall be subjected to the specified flattening resistance, impact resistance, and stiffness tests.

1.5 CLEANUP

A. In addition to the requirements of Section 01 77 00 - Project Closeout, the Contractor, upon completion of backfilling and grading over trenches, shall remove excess materials and equipment from the Site.

PART 2 -- PRODUCTS

2.1 GENERAL

A. PVC Pipe shall be continuously and permanently marked with the manufacturer's name, pipe size, and minimum pipe stiffness in psi as required in ASTM D3034 or F679.

B. Manufacturing records shall be held by the manufacturer for 2 years, covering quality control tests, raw material batch number, and other information deemed necessary by the manufacturer.

2.2 PIPE

A. Pipe shall conform to the requirements of ASTM D3034 (4-in to 15-in) or ASTM F679 (18-in to 60-in) Material for pipe shall conform to the requirements of ASTM D1784.

B. Pipe shall be SDR 26.

C. The manufacturer shall test a sample from each batch according to ASTM D2444.

D. Joints shall be gasketed push-on type conforming to ASTM D3212. Elastomeric seals for compression type joints shall conform to the requirements of ASTM F477 or ASTM F913. Joint lubricant shall be approved by the Pipe Manufacturer and shall have no detrimental effect on the gasket or pipe.

2.3 FITTINGS

A. Fittings shall conform to the requirements of ASTM D3034 or ASTM F679. The ring groove and gasket ring shall be compatible with PVC pipe ends. Flanged fittings shall be compatible with cast-iron or ductile iron pipe fittings.

B. The stiffness of the fittings shall be not less than the stiffness of adjoining pipe.

C. Fittings may also be supplied as ductile iron fittings in accordance with AWWA C110 and/or C153.

2.4 BEDDING MATERIAL

A. Unless otherwise indicated, material used for pipe bedding shall conform to Section 31 30 00 – Earthwork.

2.5 FLEXIBLE COUPLINGS

A. Flexible couplings less than 24-in in diameter shall be neoprene, full-circle, clamp-on type conforming to ASTM D5926 and shall be provided with 2 stainless steel band screw-clamps to secure the coupling tightly to entering and exiting pipes. Screw-clamp hardware shall be Type 304 or Type 316 stainless steel. Neoprene material shall be suitable for sewage service.

PART 3 -- EXECUTION

3.1 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to Section 31 23 33 – Trench bedding and Backfilling. The minimum depth of cover over the top of the pipe shall be 36-in unless otherwise indicated.

3.2 LAYING PIPE

A. Pipe shall be installed in accordance with the requirements of ASTM D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications and as indicated. Pipe sections shall be closely jointed to form a smooth flow line. Immediately before placing each section of pipe in final position for jointings, the bedding for the pipe shall be checked for firmness and uniformity of slope.

B. Handling

1. Handling of the PVC pipe shall be done with implements, tools, and facilities as recommended by the pipe manufacturer to ensure that the pipe is not damaged in any manner during storage, transit, loading, unloading, and installation.

2. Pipe shall be inspected both prior to and after installation in the ditch and all defective lengths shall be rejected and immediately removed from the working area.

3. Fittings shall be lowered into trench by means of rope, cable, chain, or other means without damage. Cable, rope, or other devices used for lowering fitting into trench, shall be attached around exterior of fitting for handling. Under no circumstances shall the cable, rope, or other device be attached through the fitting interior for handling or shall pipe or fittings be dropped or dumped into the trench.

C. Cutting and machining of the pipe shall be accomplished in accordance with the pipe manufacturer's standard procedures. Pipe shall not be cut with a cold chisel, standard iron pipe cutter, or any other method that may fracture the pipe or will produce ragged, uneven edges.

D. Foreign matter or dirt shall be removed from the interior of the pipe before lowering into position in the trench. Pipe shall be kept clean during and after laying. Openings in the pipeline shall be closed with watertight expandable type sewer plugs or PVC test plugs at the end of each day's operation or whenever the pipe openings are left unattended. The use of burlap, wood, or other similar temporary plugs will not be permitted.

E. Adequate protection and maintenance of all underground and surface utility structures, drains, sewers, and other obstructions encountered in the progress of the Work shall be the Contractor's responsibility.

F. Where the grade or alignment of the pipe is obstructed by existing utility structures such as conduits, ducts, pipes, branch connections to main sewers, or main drains, the obstruction shall be permanently supported, relocated, removed, or reconstructed by the Contractor in cooperation with owners of such utility structures. Unless otherwise indicated, protection of existing utility structures shall be the Contractor's responsibility.

3.3 FIELD JOINTING

A. Each pipe compression type joint shall be joined with a lock-in rubber ring and a ring groove that is designed to resist displacement during pipe insertion.

B. The ring and the ring seat inside the bell shall be wiped clean before the gasket is inserted. A thin film of lubricant shall be applied to the exposed surface of the ring and to the outside of the clean pipe end. Lubricant other than that furnished with the pipe shall not be used. The end of the pipe shall be then forced into the ring to complete the joint.

C. The pipe shall not be deflected either vertically or horizontally in excess of the printed recommendations of the manufacturer of the coupling.

D. Fittings shall be carefully connected to pipe, and joint shall be checked to ensure a sound and proper joint.

E. When pipe laying is not in progress, the open ends of the pipe shall be closed to prevent trench water from entering pipe. Adequate backfill shall be deposited on pipe to prevent floating of pipe. Any pipe that has floated shall be removed from the trench, cleaned, and re-laid in an acceptable manner. No pipe shall be laid when, in the opinion of the Engineer, the trench conditions or weather are unsuitable.

3.4 TESTING

A. The internal diameter of the pipe barrel shall not be reduced by more than 5 percent of its base diameter when measured after backfilling and compacting but prior to final paving and prior to leakage testing. If this amount of allowable pipe deflection is exceeded, the Contractor shall uncover the pipe and shall improve the quality of the pipe zone backfill material and/or compaction to the extent that the allowable pipe deflection is not exceeded. Excessive deflection shall be checked for by pulling a mandrel through the pipe, or by other methods acceptable to the Engineer.

B. Field testing of gravity sewer pipe shall conform to the requirements of Section 33 05 05.32 - Gravity Pipeline Testing.

END OF SECTION

SECTION 33 05 33– POLYETHYLENE PRESSURE PIPE (AWWA C906)

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide high density polyethylene (HDPE) pressure pipe, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
31 30 00	Earthwork
33 05 05	Pressure Pipe Testing and Disinfection

C. Reference Standards

American Water Works Association	
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4 In Through 65 In, for Waterworks
ASTM International (ASTM)	
ASTM D 3350	Polyethylene Plastics Pipe and Fittings Materials

1.03 CONTRACTOR SUBMITTALS

A. Furnish Shop Drawings of pipe, fittings, and appurtenances in accordance with Section 01 33 00 - Submittal Procedures.

B. Certifications: Furnish a certified affidavit of compliance for pipe and other products or materials furnished under this Section:

1. Hydrostatic proof test reports.

2. Sustained pressure test reports.

3. Burst strength test reports.

C. Expenses incurred in making samples for certification of tests shall be borne by the Contractor as part of the WORK.

1.04 QUALITY ASSURANCE

A. Each manufacturer shall have an approved in-house QA/QC program for compliance to the testing specifications and requirements of AWWA C906 for both pipe and fittings.

B. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing start date not less than 14 calendar days prior to the start of any phase of manufacture.

C. During manufacture of the pipe, the Engineer shall be given access to areas where manufacturing is in process to confirm compliance with the Specifications.

D. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of this Section and in the referenced standards, as applicable.

E. The Contractor shall perform said material tests in accordance with the requirements of the Contract Documents. The Engineer shall have the right to witness testing conducted by the Contractor, provided that the Contractor's schedule will not be delayed for the convenience of the Engineer.

F. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner. The additional samples shall be furnished as part of the WORK.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Scope: The pipe shall be between 4-in to 30-in nominal, meeting the specifications and requirements of AWWA C 906. Pipe shall be in **Ductile Iron Pipe Size (DIPS)**.

B. Materials: Pipe and fittings shall be made from prime virgin resins type 4710 exhibiting a cell classification of PE 445574C as defined in ASTM D 3350, with an established hydrostatic-design basis of 1600 psi (for water at 73 degrees F. The resin shall be listed by the PPI (Plastic Pipe Institute) in its pipe-grade registry Technical Report (TR) 4, "Listing of Plastic Pipe Compounds”.

C. Pipe and Fittings: The pressure rating shall be 160 psi. Buried pipe shall be DR 11.0 minimum. Exposed, pressure piping downstream of the membrane feed pumps shall be DR 17.0 . Laying lengths shall be 40 ft standard. Both pipe and fittings shall be listed as compliant with NSF Standard 61 and shall bear the "NSF-pw" logo or mark.

D. Joints: Pipe sections shall be joined by heat fusion. Heat fusion fittings shall meet the requirements of ASTM D3261.

E. Marking: Pipe and fittings shall be marked as prescribed by AWWA C906 . Pipe markings shall include nominal size, OD base (ie: 12-in Ductile Iron Pipe Sizing, DIPS), resin type, dimension ratio, pressure class, AWWA C906, manufacturer's name, manufacturer's production code including day, month, and year extruded, manufacturer's plant and extrusion line, and NSF - pw logo.

2.02 PLASTIC MARKING TAPE

A. The pipeline shall be marked with a magnetically detectable tracer wire, or programmable marker balls**.** The tape shall be placed along the trench centerline between 18-in and 24-in above the pipe.

PART 3 -- EXECUTION

3.01 GENERAL

A. Laying, jointing, and testing for defects and for leakage shall be performed in the presence of the Engineer and shall be subject to approval before acceptance. All material found to be defective will be rejected and the Contractor shall promptly remove such materials from the Site.

B. Installation shall conform to AWWA M55, instructions furnished by the pipe manufacturer, and to the supplementary requirements or modifications herein. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.02 HANDLING AND STORAGE

A. Handling: Pipe, fittings, and accessories shall be carefully inspected before and after installation and those found defective will be rejected. Pipe and fittings shall be free from fins and burrs. Before placing in position, clean pipe, fittings, and accessories, and maintain them in a clean condition. Proper methods shall be used for lowering sections of pipe into trenches. Under no circumstances shall pipe, fittings, or any other material be dropped or dumped into trenches.

B. Storage: Pipe shall be stored, if possible, at the Site in unit packages provided by the manufacturer. Caution should be exercised to avoid compression damage or deformation to the pipe. Pipe shall be stored in such a way as to prevent sagging or bending. Gaskets shall be stored in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.03 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to Section 31 23 33 – Trench bedding and Backfilling.

3.04 JOINING

A. The pipe shall be joined by the butt fusion procedure outlined in ASTM F2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer’s recommendations.

B. Fusion joints shall be made by qualified fusion technicians per PPI TN-42. Prior to installation of any pipe, the manufacturer shall provide training in the recommended butt fusion and saddle fusion procedures, testing procedures, and any other installation methods required by the Work. The Contractor shall record the names of trained personnel, and provide copies of certificates of their training to the Engineer.

C. On every day that butt fusion joints are to be made, the first fusion of the day shall be a test. The test fusion shall be allowed to cool completely, then fusion test straps shall be cut out. Test strap length shall be 12-in (min) or 30 times the wall thickness with the fused area in the center and width shall be 1-in (min) or 1.5 times the wall thickness. The Contractor shall bend the test strap until the ends of the strap touch. If the test strap fails at the joint, the Contractor shall perform a new test to be cooled completely and bent as before. The Contractor shall not commence installation of pipe until a test fusion has passed the bent strap test.

3.05 INSTALLATION

A. Trench shall be graded in straight lines, taking care to avoid formation of any dips or low points. Pipe shall not be laid when the conditions of trench or weather are unsuitable. At the end of each day's work, open ends of pipe shall be closed temporarily with wood blocks or bulkheads.

B. Pipe shall be cut by means of saws, power driven abrasive wheels, pipe cutters, or other manufacturer recommended methods that will produce a clean, square cut.

C. Pipe shall be supported uniformly and firmly at its proper elevation. Wood support blocking will not be permitted. The full length of each section of pipe and fittings shall rest solidly on the soil, with recesses to accommodate joints and couplings. Anchors and supports shall be provided where necessary and where indicated for fastening Work into place. Fittings shall be independently supported.

D. Short lengths of pipe shall be used in and out of each rigid joint or rigid structure.

E. Joints shall be installed according to manufacturer's recommendations. Trenches shall be kept free of water until proper backfill is in place to prevent floatation. The maximum combined deflection at any coupling shall be in accordance with the manufacturer's recommendations.

F. The bending radius shall not exceed 25 times the pipe diameter (in feet) or as recommended by the manufacturer, and shall be approved by the Engineer.

G. Where bead removal is required by the Engineer, complete the following:

1. Removing the fusion bead during the cooling stage of pipe fusion is recommended for greatest efficiency.

2. As the pipe lies in the fusion machine and before making the fusion weld slide the bead trimming machine head into the pipe, stopping 6-in away from the pipe end and confirm that the head is properly positioned.

3. Ensure that the bead trimmer machine indexing wheels and cutter blade are in their proper positions.

4. Clear away any debris that may have accumulated in front of the bead trimmer head.

5. After completion of the fusion joint and allowing enough time for the fusion bead to set up and harden, slide the bead trimmer head the remaining distance to the fusion joint.

6. After the bead trimmer has stopped on the fusion joint, release the cutter blade.

7. After the cutter is activated, continue cutting for one full revolution. Remove the bead trimmer and the removed bead.

3.06 FIELD TESTING AND DISINFECTION

A. Field testing and disinfection shall conform to the requirements of Section 33 05 05 - Pressure Pipe Testing and Disinfection.

END OF SECTION

SECTION 33 05 62 – PRECAST CONCRETE MANHOLES AND VAULTS

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide precast concrete manholes, wetwells and vaults, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
03 30 50	Cast-In-Place Concrete
10 14 00	Building Signage

C. Reference Standards

American Society for Testing and Materials (ASTM) Standards	
ASTM A48	Gray Iron Castings
ASTM C150	Portland Cement
ASTM C443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM C478/C478M	Standard Specifications for Circular Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures
ASTM C923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

1.3 CONTRACTOR SUBMITTALS

A. General: Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Show dimensions, locations, lifting inserts, reinforcement, and joints.

2. Structural design calculations for vaults, signed by a registered engineer.

a. Groundwater shall be assumed to be at the surface. Calculations shall be provided to show resistance to uplift and consider buoyant and lateral loading conditions as required in this Section.

3. Sealants for pipe penetrations through precast concrete walls.

C. Manufacturer's Certification for Precast Structures: Written certification that the structure complies with the requirements of this Section.

1.4 QUALITY ASSURANCE

A. Inspection: After installation, the Contractor shall demonstrate that concrete precast structures have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 -- PRODUCTS

2.1 MANHOLES

A. The Contractor shall provide precast manhole sections and conical sections conforming to ASTM C478 and the requirements of this Section. Adjusting rings shall be standard items from the manufacturer of the manhole sections. Minimum wall thickness of rings shall be 4-inches if steel reinforced and 6-inches if not reinforced.

B. Axial length of sections shall be selected to provide the correct total height with the fewest joints.

C. Conical sections shall be designed to support cast iron frames and covers under an H-20 loading, unless indicated otherwise.

D. Where the manhole barrel diameter is greater than 48-inches (1200 mm), a flat slab-transition, either concentric or eccentric, shall be used to transition to 48-inches (1200 mm) diameter riser sections. Underside of the transition shall be at least 7-feet (2.0 m) above the top of the bench.

E. Where indicated on the Drawings, manholes supplied for 48-inches (1200 mm) and larger pipes shall be of a "T" Base-style fabrication. The pipeline portion of the "Base T" section shall conform to ASTM C-76 and be of the same pipe class as the deepest connected sewer. The riser section shall conform to ASTM C478.

F. Design Criteria: Manhole walls, transitions, conical sections, and base shall be designed per ASTM C478 for the depths indicated and the following:

1. AASHTO H-20 loading applied to the cover.

2. Unit weight of soil of 120 pcf located above all portions of the manhole.

3. Lateral soil pressure based on saturated soil producing 100 pcf acting on an empty manhole.

4. Internal fluid pressure based on unit weight of 63 pcf with manhole filled from invert to cover with no balancing external soil pressure.

5. Dead load of manhole sections fully supported by the base and transition.

6. Additional reinforcing steel in walls to transfer stresses at openings.

7. The minimum clear distance between the edges of any 2 wall penetrations shall be 12-inches (300 mm) or one-half of the diameter of the smaller penetration, whichever is greater.

G. Joints shall be sealed with o-ring gaskets conforming to ASTM C443.

H. Concrete for base and channel formation shall be 4000 psi (27.5 MPa) concrete conforming to Section 03 30 50 - Cast-In-Place Concrete.

I. Except were otherwise indicated on the Drawings, manholes shall have a precast concrete base and a factory installed bench.

J. Barrel section to sewer pipe connections shall be sealed with resilient connectors complying with ASTM C923. Mechanical devices shall be stainless steel.

K. Manhole steps shall meet the requirements of ASTM C478 and be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches (350 mm). Furnish test results demonstrating step capability to resist a horizontal pull out force of 400 pounds (1.8 KN) and a vertical force of 800 pounds (3.6 KN). Provide PS2-PF Manhole Step by M.A. Industries or approved equal.

2.2 FRAMES AND COVERS

A. Castings: Castings for manhole frames and covers shall be non-rocking and shall conform to the requirements of ASTM A48, Class 30. Unless otherwise indicated, cast iron covers and frames shall be heavy traffic type, 24-inches in diameter. Frame and cover shall be designed for H-20 traffic loading.

B. Castings Manufacturers,

1. Alhambra Foundry Co., Ltd.

2. Neenah Foundry Co.

3. Vulcan Foundry, Inc

4. Trojan Industries

5. Norwood Foundry

6. or Approved Equal

2.3 VAULTS

A. The Contractor shall provide precast vaults designed for the indicated applications and of the sizes indicated.

B. The minimum structural member thickness for vaults shall be 5-inches. Cement shall be Type V portland cement as specified in ASTM C150. The minimum 28-day concrete compressive strength shall be 4,000 psi (27.5 MPa). All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

C. Design Loading: Vaults in areas subject to vehicular traffic shall be designed for H-20 traffic loading. Vaults in other areas shall be designed for a vertical live load of 300 psf. Lateral loads on vaults in all areas shall be calculated from:

L = 90 x h (27.44 x h), plus surcharge of 240 psf in areas of vehicular traffic

Where: L= loading in psf (kPa)

h = depth of fill in feet (meter)

D. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

E. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

F. Covers for access openings shall be provided. Frames for covers shall be fabricated from steel, galvanized after fabrication, and shall be integrally cast into the vault concrete sections. All covers shall be tight fitting to prevent the entrance of dirt and debris. Where edge seams are permitted, no gaps greater than 1/16-inch (1.6 mm) between edges will be accepted. All covers, except round, heavy weight, cast iron manhole covers, shall have securing mechanisms to hold the covers firmly in place against the effects of repetitious live loads such as pedestrian or vehicle traffic.

G. Where penetration of the pre-cast concrete vault is required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or thin-wall knock-out sections. All openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing. Vaults need not be designed to resist thrust from piping passing through the vault.

H. Steps

1. Where indicated on the Drawings, provide vault steps meeting the requirements of ASTM C478. Steps shall be comprised of 1/2-inch grade 60 steel reinforcement rod encased in polypropylene copolymer plastic. Steps shall have tread width of 14-inches (350 mm). Furnish test results demonstrating step capability to resist a horizontal pull out force of 400 pounds (1.8 KN) and a vertical force of 800 pounds (3.6 KN). Provide PS2-PF Manhole Step by M.A. Industries or approved equal.

I. Warning Signs

1. The entrance to every manhole and vault shall be fitted with a permanently affixed, plastic warning sign, located above and centered on the top step. Each sign shall be in accordance with Section 10 14 00 – Building Signage.

2. Sign Manufacturer,

    1) W. H. Brady Company

    2) Seton Nameplate Corporation

    3) or Approved Equal

J. Vaults for Solids Handling and Clarified Backwash Pump Stations

1. The requirements of the above vault section apply to these vaults with the following changes or exceptions:

    a. Provide ladders or step rungs in each vault to allow personnel access into vault as shown on the Drawings.

    b. Where indicated, provide 4-inch circular drain hole, backwater valve and compacted rock as shown on the Drawings to drain water to ground.

    c. Coordinate the support of piping and anchorage of pipe supports with manufacturer to avoid rebar.

K. Vault Manufacturers, Or Equal:

1. **H2 Precast**

2. **OldCastle**

3. **Wilbert**

PART 3 -- EXECUTION

3.1 GENERAL

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer's written recommendations. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended. Where no lifting devices are provided, the Contractor shall follow the manufacturer's recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations or bedding as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Prior to backfilling, all cracks and voids in pre-cast concrete vaults shall be filled with non-shrink grout or polyurethane sealant, or both. Around pipe and conduit penetrations, openings shall be sealed with polyurethane sealant or link seal. With the authorization of the Engineer, grout or a closed-cell flexible insulation may be used as filler material prior to placing a final bed of polyurethane sealant.

D. Steps shall be driven into tapered holes formed in the concrete by inserts from the step manufacturer or 1-inch (25 mm) holes drilled 3-3/4 inches (95 mm) deep into the manhole wall in the field. No more than 6-1/8 inches (155 mm) of plastic arm, measured on the inside of the step, shall be exposed outside the concrete.

E. Steps shall be installed 12-inches (300 mm) on centers vertically, not more than 1/2 inch (12 mm) out of plumb. The top step shall be no more then 12-inches (300 mm) below the manhole cover.

END OF SECTION

SECTION 33 46 13 - FOUNDATION DRAINAGE

PART 1 -- GENERAL

1.1 SUMMARY

A. The work under this section shall consist of providing all work, materials, labor, equipment, and supervision necessary to provide for the foundation drainage system using clay, concrete, cast iron, corrugated steel, corrugated aluminum, and plastic pipe. Connect foundation drainage pipe to the storm drainage system as shown in contract drawings. The limits of the work, including the responsible party for testing purposes, shall be clearly defined on the drawings. Included are the following topics:

1.01 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This Section incorporates by reference the latest revisions of the following documents.

1. Washington State Department of Transportation (WSDOT)

a. Wherever WSDOT appears in this specification it shall be construed to mean the pertinent sections of the Washington State Department of Transportation, Standard Specifications for Road, Bridge, and Municipal Construction M41-10 2023 or Standard Plans M21-01 current editions and all supplemental and interim supplemental specifications and updates, as they may pertain.

1.02 REFERENCE STANDARDS

American Society for Testing and Materials (ASTM) Standards	
F667/F667M	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
American Association of State Highway and Transportation Officials (AASHTO)	
AASHTO M252	Corrugated Polyethylene Drainage Pipe
AASHTO M294	Corrugated Polyethylene Pipe, 12- to 60-in Diameter
Washington Department of Transportation (WSDOT)	
9-03.12(4)	Gravel backfill for drains

1.03 CONTRACTOR SUBMITTALS

A. Material source, and all tests and certifications necessary to determine compliance with the specifications in this Section.

B. Test Reports: Submit plant and field test reports as specified in Articles 2.02 and 3.04 herein.

C. Provide manufacturer’s product information (cut sheets), shop drawings and O&M information for storm drainage materials including:

1. Pipe

2. Fittings

3. Connection of foundation underdrain pipe to stormwater system

4. Clean-outs.

D. Provide reports documenting all required testing and televising. A manufacturer's or fabricator's Certificate of Compliance shall be furnished stating that samples representing each lot have been tested and inspected in accordance with the Contract Documents and have been found to meet the requirements for the material described. Construct storm drainage system in a manner that will facilitate future extension or connection.

1.04 AS-BUILT DRAWINGS

A. Show the actual locations of storm drainage facilities and service lines and structures on drawings. Show changes to proposed storm drainage facilities, alignment, or grades. Show the actual locations, sizes and types of underground utilities and other features encountered during construction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect materials placed in storage from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Do not expose plastic pipe to direct sunlight for more than 6 months from time of manufacturer to installation.

PART 2 -- PRODUCTS

2.01 MATERIALS

A. Provide pipe for foundation drainage system of the type and size indicated on contract drawings. Use appropriate transitions, adapters, or joint details where pipes of different types or materials are connected. Submit certifications from the manufacturers attesting that materials meet specification requirements.

B. Corrugated Polyethylene (PE) Foundation Drainage Pipe: Furnish AASHTO M 252 for pipe 80 to 250 mm 3 to 10 inches in diameter or AASHTO M 294 for pipe 300 to 600 mm 12 to 24 inches in diameter. Furnish pipe manufacturer's standard fittings and conforming to the indicated specification.

C. Cleanout: Type as indicated on the Contract Drawings.

D. Joints: Type as indicated on the Contract Drawings. Seal joints watertight with prefabricated rubber or plastic gaskets or formed in place butyl rubber seal.

E. Drainage rock: Drainage rock shall be per Section 31 23 33 2.05.

F. Connections:

a. Openings for connections in pre-cast structures shall be knock-outs or cut-outs. Cut-outs shall not extend into the joint of the bottom manhole section. Provide a minimum of 12” of separation between the edge of adjacent cut-outs or knockouts. A minimum of 2” of the precast structure is required between the top of a knock-out/cut-out and the top of the structure. A minimum of 2” of precast structure is required between the side of a knock-out/cut-out and the inside face of an adjacent sidewall.

G. Circular Perforations in Plastic Pipe: Cleanly cut circular holes no more than 5/16 inch or less than 3/16 inch in diameter, and arrange in rows parallel to the longitudinal axis of the pipe. Place perforations approximately 3 inches apart, center-to-center, along rows. Place rows approximately 1-1/2 inches apart and arrange in a staggered pattern so that all perforations lie at the midpoint between perforations in adjacent rows. Space rows no more than 155 degrees of circumference. Do not perforate the spigot or tongue end of the pipe for a length equal to the depth of the socket and continue perforations at uniform spacing over the entire length of the pipe.

H. Slotted Perforations in Plastic Pipe: Cleanly cut circumferential slots so as not to restrict the inflow of water and uniformly spaced along the length and circumference of the tubing. Width of slots exceeding 1/8 inch or less than 1/32 inch is not permitted. Length of individual slots exceeding 1-1/4 inches on 3 inch diameter pipe is not permitted; 10 percent of the pipe inside nominal circumference on 4 to 8 inch diameter pipe; and 2-1/2 inches on 10 inch diameter tubing. Symmetrically space rows of slots so that they are fully contained in quadrants of the pipe. Center slots in the valleys of the corrugations of profile wall pipe. Provide water inlet area consisting of a minimum of 0.5 square inch/linear foot of tubing.

PART 3 -- EXECUTION

3.01 EXAMINATION

A. Complete exploratory excavations at utility crossings as shown on the drawings and as necessary to complete the work. Notify the design engineer of utility conflicts as soon as they are encountered.

3.02 PREPARATION

A. Store and handle pipe in accordance with manufacturers’ recommendations. Keep pipes clean of soil, debris and animals.

3.03 TRENCHING AND EXCAVATION

A. A. Perform required trenching and excavation in accordance with Section 31 23 33 – Trench Bedding and Backfill. Keep trenches dry during installation of drainage system. Make changes in direction of drain lines with 1/8 bends. Use wye fittings at intersections.

3.04 LAYING PIPE

A. Lay drain lines to true grades and alignment with a continuous fall in the direction of flow. Face bells of pipe sections upgrade. Clean interior of pipe thoroughly before being laid. When drain lines are left open for connection to discharge lines, temporarily close the open ends and mark the location with wooden stakes. Lay perforated pipe with perforations facing down. Remove and relay any length that has had its grade or joints disturbed. Install perforated corrugated polyethylene drainage piping in accordance with manufacturer's specifications and as specified herein. Do not install piping with physical imperfections. Do not use any pipe or fittings cracked in cutting or handling or otherwise not free from defects.

3.05 JOINTING

A. Perforated and Porous Pipes: Lay perforated and porous types of drain pipes with closed joints. Make joints in accordance with manufacturer's directions with due care to avoid damaging pipe and/or disturbing previously laid pipe.

3.06 CORRUGATED POLYETHYLENE

A. Furnish corrugated polyethylene (PE) pipe joints in accordance with ASTM F667/F667M or ASTM F667/F667M.

3.07 CLEANOUTS

A. Provide cleanouts in locations indicated on contract drawings. Set cleanouts in unpaved areas as much as possible.

3.08 BEDDING/UTILITY COVER:

A. Follow requirements of Section 31 23 33 – Trench Bedding and Backfill . Place graded bedding, minimum 6 inches in depth, in the bottom of trench for its full width and length compacted as specified prior to laying of foundation drain pipe. Rest each section firmly upon the bedding, through the entire length, with recesses formed for bell joints. Except for recesses for bell joints, fully support the lower quadrant of the pipe.

3.09 CONNECTIONS TO EXISTING STRUCTURES:

A. Make all necessary openings into existing structures or drainage pipes including the reconstruction of existing inverts or benches, as necessary. Patch all openings permanently watertight with concrete brick and mortar, hydraulic cement, or flexible watertight boots.

3.11 BACKFILLING:

A. After joints and connections have been inspected and approved, place the specified pervious backfill material 6 inches on each side of the pipe for the full width of the trench and full width between pipe and adjacent walls and 12 inches above the top of the pipe. Place the backfill preventing displacement of or injury to the pipe or tile. Place a protective covering, as specified, over the pervious backfill for the full width of the trench before regular backfill is placed. Compact backfill as specified in Section 31 23 33 Trench Bedding and Backfill.

END OF SECTION

SECTION 33 92 20 - DUCTILE IRON PIPING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide ductile iron pipe and appurtenant Work, complete and in place, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110	Ductile-Iron and Gray-Iron Fittings, 3 in through 48 in for Water
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
AWWA C150	Thickness Design of Ductile-Iron Pipe
AWWA C151	Ductile-Iron Pipe, Centrifugally Cast for Water
AWWA C153	Ductile-Iron Compact Fittings. for Water Service
AWWA C600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C606	Grooved and Shouldered Joints
ASTM C 150	Portland Cement

1.3 CONTRACTOR SUBMITTALS

A. Furnish Submittals in accordance with Section 01 33 00 – Submittal Procedures and the following supplemental requirements:

B. Shop Drawings

1. Certified dimensional drawings of valves, fittings, and appurtenances.

2. For pipe 24-inches diameter and larger, line layout and marking diagrams which indicate the specific number of each fitting and the location and the direction of each

fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at changes in grade or horizontal alignment; elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained joints, or of concrete encasement.

C. Certifications: Certified affidavit of compliance for pipe and other products or materials furnished under this Section and as specified in the referenced standards and the following supplemental requirements:

1. Physical and chemical properties.

2. Hydrostatic test reports.

D. The Contractor shall be responsible for performing and paying for sampling and testing as necessary for the certifications.

1.4 QUALITY ASSURANCE

A. Tests: Except as modified herein, materials used in the manufacture of the pipe shall be tested in accordance with the requirements of the referenced standards as applicable.

B. The Contractor shall perform said material tests as part of the Work. The Engineer shall have the right to witness testing conducted by the Contractor; provided, that the Contractor's schedule is not delayed for the convenience of the Engineer.

C. In addition to those tests specifically required, the Engineer may request additional samples of any material including lining and coating samples for testing by the Owner. The additional samples shall be furnished as a part of the Work.

D. Inspection: Pipe shall be subject to inspection at the place of manufacture in accordance with the provisions of the referenced standards, as supplemented by the requirements herein. The Contractor shall notify the Engineer in writing of the manufacturing starting date not less than 14 Days prior to the start of any phase of the pipe manufacture.

E. During the manufacture of the pipe, the Engineer shall be given access to areas where manufacturing is in process and shall be permitted to make inspections necessary to confirm compliance with the Specifications.

PART 2 -- PRODUCTS

2.1 PIPE GENERAL

A. Mortar-lined and polyethylene-wrapped ductile iron pipe shall conform to AWWA C151, C104, and C105 subject to the supplemental requirements in this Section. The pipe shall be of the diameter and class indicated, shall be provided complete with rubber gaskets, specials, and fittings as required under the Contract Documents.

B. Markings: The Contractor shall legibly mark specials 24-inches diameter and larger in accordance with the laying schedule and marking diagram. Each fitting shall be marked at each end with top field centerline.

C. Handling and Storage: The pipe shall be handled as a minimum at the 1/3 points by use of wide slings, padded cradles, or other devices designed and constructed to prevent

damage to the pipe coating/exterior. The use of chains, hooks, or other equipment that might injure the pipe coating/exterior will not be permitted. Stockpiled pipe shall be supported on padded skids, sand or earth berms free of rock exceeding 3-inches diameter, sand bags, or suitable means so that the coating will not be damaged. The pipe shall not be rolled and shall be secured to prevent accidental rolling.

D. Laying Lengths: Nominal pipe laying lengths shall be 20-feet.

E. Finish: The pipe shall have smooth dense interior surfaces and shall be free from fractures, excessive interior surface crazing, and roughness.

F. Closures and Correction Pieces: Closures and correction pieces shall be provided as required so that closures may be made due to different headings in the pipe laying operation and so that correction may be made to adjust the pipe laying to conform to pipe stationing on the Drawings. The locations of correction pieces and closure assemblies are indicated. Any change in location or number of said items shall only be as accepted by the Engineer.

2.2 SPECIALS AND FITTINGS

A. Fittings for ductile iron pipe shall conform to the requirements of AWWA C153 or AWWA C110 and shall have a minimum pressure rating of 250 psi. Ductile iron fittings larger than 48-inches shall conform to AWWA C153.

2.3 DESIGN OF PIPE

A. The pipe shall be designed, manufactured, tested, inspected, and marked according to AWWA C150 and C 151 except where modified by this Section.

B. Pipe Dimensions: The pipe shall be of the diameter and class indicated.

C. Fitting Dimensions: The fittings shall be of the diameter and class indicated.

D. Joint Design: Ductile iron pipe and fittings for buried pressure service shall be furnished with restrained joints, unless otherwise indicated. Ductile iron pipe and fittings for buried gravity service shall be furnished with mechanical joints or push-on joints as required, unless otherwise indicated. Above ground ductile iron pipe and fittings joints shall be as indicated. Flanged joints or grooved and shouldered joints shall be furnished where required.

1. Mechanical and push-on joints shall conform to AWWA C111.

2. Flanged joints shall conform to AWWA C115. Where threaded flanges are provided, the pipe wall thickness under the cut threads shall not be less than the calculated net thickness required for the pressure class of the pipe.

3. Restrained joints shall be **Field-Lok** restrained joint by **U.S. Pipe**, **Flex-Ring** by **American D.I. Pipe**, or equal.

4. Joint restraining devices that impart point loads and/or wedging action on the pipe wall as a means of joint restraint shall not be allowed unless there are no other options for joint restraint available. Under such circumstances, the Contractor may propose such devices provided the following conditions are met and the request is made as a substitution:

a. A formal request for substitution is submitted stating the locations where the devices are intended to be used and a statement from the device manufacturer and the pipe manufacturer that the proposed device is appropriate for the intended installation and is rated at least for the class of the pipe being supplied.

b. A statement from the pipe manufacturer is provided accepting the use of the retaining devices and indicating that the use of such devices will in no way affect the warranty of the pipe and/or the performance of the pipe.

c. The manufacturer of the device and the pipe manufacturer jointly provide instruction on the proper installation of the device to the personnel installing the units and provide certification to the Owner that the installers are adequately trained in the installation of the units and that warranties are in full affect for the project.

d. The devices shall be **MegaLug Model 1100** as manufactured by **EBAA Iron** or equal. The restraint shall be stainless steel.

5. Grooved and Shouldered Joints shall meet the requirements of mechanical-type couplings in accordance with Section 40 05 01 – Piping General and conform to AWWA C606.

E. For bell-and-spigot ends with rubber gaskets, the clearance between the bells and spigots shall be such that when combined with the gasket groove configuration and the gasket itself, will provide watertight joints under all operating conditions when properly installed. The Contractor shall require the pipe manufacturer to submit details complete with significant dimensions and tolerances and also to submit performance data indicating that the proposed joint has performed satisfactorily under similar conditions. In the absence of a history of field performance, the results of a test program shall be submitted.

2.4 CEMENT-MORTAR LINING

A. Cement-Mortar Lining for Shop Application: Except as otherwise provided herein, interior surfaces of ductile iron pipe, fittings, and specials shall be cleaned and lined in the shop with cement-mortar lining applied centrifugally in conformity with AWWA C104. During the lining operation and thereafter, the pipe shall be maintained in a round condition by suitable bracing or strutting. The lining machines shall be of a type that has been used successfully for similar work. Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found defective at the Site, the damaged or unsatisfactory portions shall be replaced with lining conforming to these Specifications.

1. Cement: Cement for mortar lining shall conform to the requirements of AWWA C104; provided, that cement for mortar lining shall be Type II or V. Cement shall not originate from kilns that burn metal-rich hazardous waste fuel, nor shall a fly ash or pozzolan be used as a cement replacement.

B. The minimum lining thickness shall be as follows:

Nominal Pipe Diameter, inches	**Minimum Lining Thickness, inches**
3 - 12	1/16

14 - 24	3/32
30 - 64	1/8

2.5 EXTERIOR PROTECTION OF PIPE

A. Exterior Coating of Exposed Piping: The exterior surfaces of pipe which will be exposed to the atmosphere inside structures or above ground shall be thoroughly cleaned and then given a shop coat of rust-inhibitive primer conforming to the requirements of Section 09 96 00 – High Performance Coating.

B. Exterior Coating of Buried Piping: The exterior coating shall be an asphaltic coating approximately 1-mil thick.

C. Polyethylene Sleeve: Sleeves shall conform to the requirements of AWWA C105, Contractor's choice between tubular 8-mil thick linear low-density film or 4-mil thick high-density cross-laminated film. Color shall be white**.**

PART 3 -- EXECUTION

3.1 INSTALLATION OF PIPE

A. The Contractor shall inspect each pipe and fitting prior to installation to ensure that there are no damaged portions of the pipe. Pipe damaged prior to Substantial Completion shall be repaired or replaced by the Contractor.

B. Before placement of pipe in the trench, each pipe or fitting shall be thoroughly cleaned of any foreign substance which may have collected thereon and shall be kept clean at all times thereafter. For this purpose, the openings of pipes and fittings in the trench shall be closed during any interruption to the Work.

C. Pipe Laying: The pipe shall be installed in accordance with AWWA C600.

D. Pipe shall be laid directly on the bedding material. No blocking will be permitted, and the bedding shall be such that it forms a continuous, solid bearing for the full length of the pipe. Excavations shall be made as needed to facilitate removal of handling devices after the pipe is laid. Bell holes shall be formed at the ends of the pipe to prevent point loading at the bells or couplings. Excavation shall be made as needed outside the normal trench section at field joints to permit adequate access to the joints for field connection operations and for application of coating on field joints.

E. Each section of pipe 24-inches diameter and larger shall be laid in the order and position shown on the laying schedule. Each section shall be laid to the line and grade, within approximately one-inch plus or minus.

F. Where necessary to raise or lower the pipe due to unforeseen obstructions or other causes, the Engineer may change the alignment and/or the grades. Such change shall be made by the deflection of joints, by the use of bevel adapters, or by the use of additional fittings. However, in no case shall the deflection in the joint exceed 75 percent of the

maximum deflection recommended by the pipe manufacturer. No joint shall be misfit any amount that will be detrimental to the strength and water tightness of the finished joint.

G. Except for short runs that may be permitted by the Engineer, pipes shall be laid uphill on grades exceeding 10 percent. Pipe that is laid on a downhill grade shall be blocked and held in place until sufficient support is furnished by the following pipe to prevent movement. Bends shall be properly installed as indicated.

H. Cold Weather Protection: No pipe shall be installed upon a foundation into which frost has penetrated or at any time that there is a danger of the formation of ice or penetration of frost at the bottom of the excavation before backfilling occurs.

I. Pipe and Specials Protection: The openings of pipe and specials shall be protected with suitable bulkheads to prevent unauthorized access by persons, animals, water, or any undesirable substance. At all times, means shall be provided to prevent the pipe from floating.

J. Pipe Cleanup: As pipe laying progresses, the Contractor shall keep the pipe interior free of debris. The Contractor shall completely clean the interior of the pipe of sand, dirt, mortar splatter, and any other debris following completion of pipe laying and shall perform any necessary interior repairs prior to testing and disinfecting the completed pipeline.

3.2 RUBBER GASKETED JOINTS

A. Rubber Gasketed Joints: Immediately before jointing pipe, the bell end of the pipe shall be thoroughly cleaned, and a clean rubber gasket shall be placed in the bell groove. The spigot end of the pipe and the inside surface of the gasket shall be carefully cleaned and lubricated. The lubricant shall be suitable for lubricating the parts of the joint for assembly and be a compound listed as in compliance with NSF Standard 61. The lubricant shall be nontoxic, shall not support the growth of bacteria, and shall have no deleterious effects on the gasket material. The lubricant shall not impart taste or odor to water in the pipe. The spigot end of the pipe section shall then be inserted into the bell of the previously laid joint and telescoped into its proper position. Tilting of the pipe to insert the spigot into the bell will not be permitted.

3.3 POLYETHYLENE SLEEVE UNBONDED PROTECTION

A. Buried ductile iron pipe shall be polyethylene encased in accordance with the requirements of AWWA C105, Contractor's choice between Method A or Method B.

3.4 INSTALLATION OF PIPE APPURTENANCES

A. Protection of Appurtenances: Where the joining pipe is dielectric-coated, buried appurtenances shall be coated in kind. Where pipe is encased in polyethylene sleeves, buried appurtenances shall be encased in polyethylene.

B. Installation of Valves: Valves shall be handled in a manner to prevent any injury or damage to any part of the valve. Joints shall be thoroughly cleaned and prepared prior to installation. The Contractor shall adjust stem packing and operate each valve prior to installation to insure proper operation.

C. Valves shall be installed so that the valve stems are plumb and in the location indicated.

END OF SECTION

SECTION 33 95 50 – PVC PRESSURE PIPE, ELASTOMER JOINTS

PART 1 -- GENERAL.

1.1 SUMMARY

A. Provide polyvinyl chloride (PVC) pressure pipe, complete in place, as indicated in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00– Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
09 96 00	High Performance Coating
31 30 00	Earthwork
33 05 33	Pressure Pipe Testing and Disinfection
40 05 02	Piping Identification

C. Reference Standards

AWWA C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C110	Ductile-Iron and Gray-Iron Fittings 3-in Through 48-in for Water and Other Liquids
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C600	Installation of Ductile-Iron Water Mains and Appurtenances
AWWA C605	Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
AWWA C907	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. through 12 In., for Water, Wastewater, and Reclaimed Water Service
AWWA C909	Molecularly Oriented Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. and Larger
ASTM F 1674	Joint Restraints for PVC
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins
PPI Technical Report TR-3	Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials
AWWA Manual M23	PVC Pipe - Design and Installation
CSA B137.3	Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit product data for pipe, fittings, and appurtenances 16-inch diameter and smaller.

2. Submit drawings for pipe, fittings, and appurtenances larger than 16-inch diameter.

3. Furnish manufacturer's literature for detectable metallic warning tape.

C. Certifications

1. Furnish manufacturer’s certification of compliance for pipe and other products or materials under this Section. Certification to include the following:

a. hydrostatic proof test;

b. sustained pressure test; and,

c. burst strength test.

1.4 QUALITY ASSURANCE

A. Inspection

1. Pipe manufacturing process shall be subject to inspection at the place of manufacture.

2. The Engineer shall be given access to areas where manufacturing is in process and shall be permitted to make inspections to confirm compliance with the indicated Specifications.

B. Testing

1. Materials used in the manufacture of the pipe to be in accordance with the requirements of this Section and the referenced standards, as applicable.

2. The Engineer shall have the right to witness manufacturer’s testing procedures.

C. Additional Samples

1. In addition to those tests specifically required, the Engineer may request additional samples of any material for testing by the Owner.

2. Furnish the additional samples as a part of the Work.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Provide PVC pressure pipe conforming to the applicable requirements of AWWA C900, AWWA C907, AWWA C909, and the requirements indicated in this Section.

2.2 PIPE

A. Provide pipe of the indicated diameter and pressure class.

B. Provide specials and fittings as indicated. Fittings to match pipe pressure class unless indicated otherwise.

C. The dimensions and pressure classes for Dimension Ratios for PVC pressure pipe with Cast-Iron Pipe Equivalent O.D.'s shall conform to the requirements of AWWA C900.

D. Elastomeric Joints

1. Joints for buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing an elastomer ring joint, or removeable gaskets.

2. Provide the bell and coupling of the same or greater pressure rating as of the pipe barrel.

3. Provide the sealing ring groove in the coupling of the same design as the groove in cast iron fittings and valves available from local water works supply distributors.

E. Joint Deflection

1. Deflection at the joint shall not exceed 1.5 degrees or the maximum deflection recommended by the manufacturer.

2. No deflection of the joint will be accepted for joints that are over-belled or not belled to the stop mark.

F. Restrained Joints

1. Where indicated, provide restrained joint PVC pipe.

2. Restrained joint PVC pipe shall be internally restrained or fusible PVC. The use of rods and clamps for joint restraint is not permitted.

3. Integrally Restrained PVC

a. Internally restrained PVC pipe shall be joined using non-metallic couplings to form an integral system. EPDM gaskets shall be inserted into mating, precision machined grooves in the pipe and coupling to provide full 360° restraint with evenly distributed loading.

b. Approved products and manufacturers:

1) TerraBrute CR Restrained Joint PVC Pipe, IPEX

2) Certa-Lok RJIB PVC Pipe, Westlake

4. Fusible PVC

a. Fusible PVC restrained joints shall be of the heat fusion (butt fusion) joining system. A factory trained, licensed representative from the Contractor shall be on-site to complete the heat fusing of each section of Fusible PVC pipe. The Contractor's representative shall be trained and licensed by the pipe manufacturer.

b. Approved products and manufacturer’s

1) Fusible PVC, Underground Solutions

2.3 FITTINGS

A. Provide ductile iron fittings conforming to the requirements of AWWA C110, Class 250.

1. Line and coat fittings in accordance with the requirements of Section 09 96 00 – High Performance Coating.

B. Provide PVC pipe fittings conforming to the requirements of AWWA C900 or AWWA C907.

C. Clearly label each fitting in order to identify its size and pressure class.

PART 3 -- EXECUTION

3.1 GENERAL

A. Perform laying, jointing, and testing for defects and leakage in the presence of the Owner or Engineer, and obtain the Owner’s or Engineer's approval before acceptance.

B. Material found to have defects will be rejected, and the Contractor shall promptly remove such defective materials from the Site.

C. Installation shall conform to the requirements of AWWA M23, instructions furnished by the pipe manufacturer, and to the supplementary requirements indicated herein.

D. Wherever the provisions of this Section and the aforementioned requirements are in conflict, the more stringent provision shall apply.

3.2 HANDLING AND STORAGE

A. Handling

1. Carefully inspect pipe, fittings, and accessories before and after installation, and reject those found to be defective.

2. Before being placed in position, clean the pipe, fittings, and accessories and maintain them in a clean condition.

3. Provide proper equipment for lowering sections of pipe into trenches.

4. Under no circumstances drop or dump pipe, fittings, or any other material into trenches.

B. Storage

1. Store pipe, if possible, at the Site in unit packages provided by the manufacturer.

2. Exercise caution to avoid compression damage or deformation to bell ends of the pipe.

3. Store pipe in such a way as to prevent sagging or bending, and protect pipe from exposure to direct sunlight by covering with an opaque material while permitting adequate air circulation above and around the pipe if stored for long periods of time (greater than one year).

4. Store gaskets in a cool, dark place out of the direct rays of the sun, preferably in original cartons.

3.3 TRENCHING AND BACKFILL

A. Trench excavation and backfill shall conform to the requirements of Section 31 30 00 – Earthwork..

3.4 INSTALLATION

A. Lay bell-and-spigot pipe with the bell end pointing in the direction of laying.

B. Grade the pipe in straight lines, taking care to avoid the formation of any dips or low points.

C. Do not lay pipe when the conditions of trench or weather are unsuitable.

D. At the end of each day's Work, temporarily close the open ends of pipe with wood blocks or bulkheads.

E. Supports

1. Support pipe at its proper elevation and grade, taking care to provide firm and uniform support.

2. Wood support blocking will not be accepted.

3. The full length of each section of pipe and fittings shall rest solidly on the pipe bed, with a recessed excavation in order to accommodate bells, joints, and couplings.

4. Provide anchors and supports where indicated and where necessary for fastening Work into place.

5. Independently support fittings.

F. Use short lengths of pipe in and out of each rigid joint or rigid structure.

G. Replace piping that does not allow sufficient space for proper installation of jointing material with piping of proper dimensions.

H. Blocking or wedging between bells and spigots will not be accepted.

I. Install joints in accordance with the manufacturer's recommendations.

J. Keep trenches free of water until joints have been properly made.

K. Provide depth of cover equal to 1.5 times the pipe diameter where high groundwater is expected or encountered.

L. The maximum combined deflection at couplings shall be in accordance with the manufacturer's recommendations.

M. Cutting

1. Cut pipe by means of saws, power-driven abrasive wheels, or pipe cutters, which will produce a square cut.

2. Cuts by wedge-type roller cutters will not be accepted.

3. After cutting, bevel the end of the pipe using a beveling tool, portable type sander, or abrasive disc.

N. Integrally Restrained Joints

1. Follow the manufacturer’s written instructions for installation of joints.

a. Clean pipe and coupling (RJ) to remove debris and contaminants.

b. Inspect the seal inside the pipe for placement and alignment.

c. Apply manufacturer recommended lubricant to the gasket seal and spigot end. Remove any lubricant that may have gotten into the spline grove.

d. Ensure pipe ends are concentrically and angularly aligned. Verify the spline hole is accessible.

e. Push the pipe together using mechanical means, either into the coupling (RJ joint) or bell and spigot (RJIB) and insert the nylon spline using a spline insertion tool until it bottoms out.

f. Excess spline beyond 1 inch, may be cut off.

2. Follow the manufacturer’s recommendations to connect an integrally restrained joint product to standard PVC pipe.

O. Fusible Joints:

1. General

a. Use temporary shelter over fusion operations during inclement weather; protect operations from precipitation and cold winds.

b. Support pipe in a manner not to exceed the allowable bend radius, corrected for actual temperature, during welding or installation into the ground.

c. When installing fusible joints, use a pulling head designed for fusible PVC and for the specific pipe diameter to be used.

2. Butt-welding

a. Ensure the electronic data logger is recording critical pipe fusion information for each joint.

b. Securely align the pipe ends in the fusion machine.

c. Use the fusion machine's dual cutting heads to face and square the ends of the PVC pipe.

d. Heat the pipe ends to the proper bead formation, remove the heating element and bring the ends together.

e. Hold the joined pipe segments under pressure until the joint cools to the proper temperature.

f. Do not remove internal or external beads.

g. Final report of recorded data to be reviewed by the Engineer.

3.5 INSTALLATION OF METALLIC TRACER TAPE

A. Provide metallic tracer tape in accordance with Section 40 05 02 - Piping Identification.

3.6 SERVICE CONNECTIONS

A. Direct tapping will not be accepted.

B. Use double-strap bronze service clamps for service connections.

C. Provide service clamps with a bearing area of sufficient width along the axis of the pipe such that the pipe will not be distorted when the saddle is made tight.

D. Cutting

1. Use an internal shell cutter to drill through the corporation stop in order to minimize PVC shavings, retain the coupon, and reduce stress.

2. Cuts by single-fluted shell cutters or twist drills will not be accepted.

3. Make the cuts slowly, use the follower very lightly, and do not force the cutter through pipe wall.

4. Provide the shell cutter with sufficient throat depth to handle the heavy-wall PVC pipe.

5. Maximum outlet size permitted with service clamps or saddle is 2-inches.

E. Tapping Sleeves

1. Use tapping sleeves and valves for outlet sizes greater than 2 inches in diameter.

2. Assemble and install tapping sleeves in accordance with the manufacturer's recommendations.

3.7 CONNECTIONS TO EXISTING PIPELINES

A. Locate underground improvements and install the pipelines to the indicated depths.

B. Where the new Work is to be connected to existing pipelines, make arrangements with the serving utility well in advance of the connections in order to allow adequate time for dewatering of the existing line, if necessary, and expedite the Work in order to minimize water outages to the users.

C. Where sections of existing distribution mains are taken permanently out of service and abandoned in place, plug the cut ends solid with concrete to a depth of not less than one pipe diameter.

3.8 FIELD TESTING AND DISINFECTION

A. Field testing and disinfection of water mains shall conform to the requirements of Section 33 05 05 – Pressure Pipe Testing and Disinfection.

END OF SECTION

SECTION 40 05 01– PIPING GENERAL

PART 1 -- GENERAL

1.01 SUMMARY

A. The Contractor shall provide piping systems indicated, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings and as indicated in the Piping Schedule.

C. The Drawings define the general layout, configuration, routing, method of support, pipe size, and pipe type. The Drawings are not pipe construction or fabrication drawings. The Contractor shall prepare pipe spooling and fabrication drawings and shall submit them to the Engineer for review.

D. Where pipe layout details are not indicated on the Drawings, it is the Contractor's responsibility to develop the details necessary to design and construct piping systems to accommodate the specific equipment provided, and to provide spacers, adapters, and connectors for a complete and functional system.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Definitions

1. Pipe, piping, pipe work, pipe system, piping system, or similar words, singular or plural shall mean and include, any type of pipes, tubes, fittings, valves, piping specialties, appurtenances, supports, restraints, anchors, coatings and linings and items related to piping.

2. Submerged piping, underwater piping, or similar words, shall include any piping located 2 feet above water surface in basins or tanks

3. Potable water or similar words shall mean and include any type of potable water or process water that be deemed potable after treatment processes.

4. Corrosive service shall mean and include in locations listed below:

a. Buried locations

b. Submerged locations or submerged piping.

c. Inside buried vaults, manholes, and structures that do not drain through a gravity sewer or to a sump with a pump.

d. Chemical handling areas

e. Inside trenches, containment walls, and curbed areas

f. Locations indicated or designated in the contract documents.

C. Reference Specifications

Division 33	Utilities
Division 40	Process Interconnections
01 33 00	Submittals Procedures
01 33 17	Structural Design, Support and Anchorage
09 96 00.10	High-Performance Coatings
26 05 50	Electric Heat Tracing
33 05 05	Pressure Pipe Testing and Disinfection
40 05 07	Pipe Supports
43 07 00	Process Piping and Equipment Insulation

D. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
ASME B1.20.1	Pipe Threads, General Purpose
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B31	Boiler and Pressure Vessel Code, Section 9
ASME B31.1	Power Piping
ASTM International (ASTM)	
ASTM A193	Standard Specification for Alloy-Steel and Stainless-Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A194	Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both
ASTM A307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM D792	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC)
ASTM F436	Hardened Steel Washers
ASTM F467	Standard Specification for Nonferrous Nuts for General Use
ASTM F468	Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
ASTM F493	Standard Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

American Welding Society (AWS)	
AWS D1.1	Structural Welding Code
American Water Works Association (AWWA)	
AWWA C115	Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C606	Grooved and Shouldered Joints

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Drawings: Layout drawings including necessary dimensions, details, pipe joints, fittings, specials, bolts and nuts, gaskets, valves, appurtenances, anchors, guides, and material lists. Pipe spooling and fabrication drawings shall indicate spacers, adapters, connectors, fittings, and pipe supports to accommodate the equipment and valves in a complete and functional system.

2. Welding Qualifications and Procedures

3. Pipe Supports: Submit pipe support fabrication drawings including calculations in accordance with Section 40 05 07 - Pipe Supports.

4. Grooved joint couplings and fittings shall be shown on drawings and product submittals and shall be specifically identified with the applicable style or series designation, and restraint system if applicable.

5. Thermoplastic Pipe Joints: Submit solvent cement manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

6. Gasket Material: Submit gasket manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

7. Seals and Seating Materials: Submit elastomer material and manufacturer's catalog indicating that the recommended product is suitable for each fluid service application.

8. Modular Seals for Pipe: Manufacturer's catalog sheet showing materials and installation procedures.

9. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and anchors and guides, including information on materials, temperature, and pressure ratings

10. Flexible Connectors: Submit pressure and thermal expansion calculations

C. Samples

1. Performing and paying for sampling and testing as necessary for certifications are the Contractor's responsibility.

D. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.

2. A certification from the pipe fabricator that each pipe will be manufactured subject to the fabricators or a recognized Quality Control Program. An outline of the program shall be submitted to the Engineer for review prior to the manufacture of any pipe.

1.04 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping materials, fittings, valves, and accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Extent of Work

1. Pipes, fittings, and appurtenances shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. Materials in contact with potable water or process water that be deemed potable after treatment processes shall be listed as compliant with NSF Standard 61.

B. Piping Supports

1. Pipes shall be adequately supported, restrained, and anchored in accordance with Section 40 05 07 – Pipe Supports, and as indicated.

2. Piping support seismic and wind loads shall be sized in accordance with the design criteria as specified in Section 01 33 17– Structural Design, Support and Anchorage.

C. Lining

1. Application, thickness, and curing of pipe lining shall be in accordance with the applicable Sections of Division 33, unless otherwise indicated.

D. Coating

1. Application, thickness, and curing of coating on buried pipe shall be in accordance with the applicable Sections of Division 33 and Section 09 96 00.10 - High Performance Coatings, unless otherwise indicated.

2. Pipes above ground or in structures shall be coated in accordance with Section 09 96 00.10 – High-Performance Coatings.

E. Pressure Rating

1. Piping systems shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

F. Inspection

1. Pipe shall be subject to inspection at the place of manufacture.

2. During the manufacture, the Engineer shall be given access to areas where manufacturing is in progress and shall be permitted to make inspections necessary to confirm compliance with requirements.

G. Tests

1. Except where otherwise indicated, materials used in the manufacture of the pipe shall be tested in accordance with the applicable specifications and standards.

2. Welds for steel process piping shall be tested as indicated in 40 05 24 – Steel Process Pipe.

3. The Contractor shall be responsible for performing material tests.

H. Welding Requirements

1. Qualification of welding procedures used to fabricate pipe shall be in accordance with the provisions of AWS D1.1 - Structural Welding Code or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.

I. Welder Qualifications

1. Welding shall be performed by skilled welders and welding operators who have adequate experience in the methods and materials to be used.

2. Welders shall be qualified under the provisions of AWS D1.1 or the ASME Boiler and Pressure Vessel Code, Section 9, whichever is applicable.

3. Machines and electrodes similar to those used in the Work shall be used in qualification tests.

4. Qualification testing of welders and materials used during testing is part of the Work.

2.02 PIPE FLANGES

A. General

1. Flanges shall be provided with flat faces and shall be attached with bolt holes straddling the vertical axis of the pipe unless otherwise indicated.

2. Flange faces shall be perpendicular to the axis of the adjoining pipe.

3. Flanges for miscellaneous small diameter pipes shall be in accordance with the standards indicated for those pipes.

B. Pressure Ratings

1. 150 psig or less: Flanges shall conform to either AWWA C207 - Steel Pipe Flanges for Waterworks Service--Sizes 4-in through 144-in., Class D, or ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2. 150 psig to 275 psig: Flanges shall conform to either AWWA C207 Class E or Class F, or ASME B16.5, Class 150.

3. 275 psig to 700 psig: Flanges shall conform to ASME B16.5, Class 300.

4. Selection Based on Test Pressure

a. Do not expose AWWA flanges to test pressures greater than 125 percent of rated capacity.

b. For higher test pressures, the next higher rated AWWA flange or an ANSI-rated flange shall be selected.

C. Blind Flanges

1. Provide blind flanges in accordance with AWWA C207, or as indicated for miscellaneous small pipes.

2. Blind flanges for pipe diameters 12-in and greater shall be provided with lifting eyes in the form of welded or threaded eye bolts.

D. Flange Coating

1. Machined faces of metal blind flanges and pipe flanges shall be coated with a temporary rust-inhibitive coating to protect the metal until the installation is completed.

E. Flange Fasteners

1. Unless otherwise shown on the drawings, or indicated in the applicable Sections of Divisions 33 and 40, Bolts and nuts shall conform to the following requirements;

a. Threads shall be in accordance with ANSI/ASME B1.1, Class 2, UNC for bolt diameters 1-in and smaller and UN8 for bolt diameters greater than 1-in.

b. Bolts shall have heavy hexagon heads and heavy hexagon nuts. Length of studs shall provide a projection of not less than 0.25 inch and no more than 0.5-in through the nut when it is drawn tight.

c. Thread studs on flange connections are not permitted except where space restrictions preclude the use of standard bolts and where approved by the Engineer.

d. Through bolt holes shall be drilled in accordance with the applicable flange standard.

e. All bolts fastening metallic flanges shall be provided with plain washers installed under the nut. Washer materials shall be of the same material as the bolt. If the through bolt holes are drilled larger than the applicable standard by 1/8-in in diameter or more, bolts shall be also installed with a plain washer under the bolt head as well.

f. All bolts fastening non-metallic flanges shall be provided with plain washers installed under both the bolt head and nut.

g. Washer materials shall be of the same material as the bolt.

h. Anti-seize compound shall be used on carbon steel fasteners, and shall be Husk-ITT, Husky 2000; or equal.

i. Anti-galling compound used for stainless steel fasteners in LOX, nitrogen injection, oxygen, ozone process/off-gas/vent and ozone contactor maintenance air service shall be DuPont “Krytox”; or equal.

j. Anti-galling compound used for stainless steel fasteners for other services shall be certified for potable water use and shall be Husk-ITT, Lube O’seal; Hercules, Real-Tuff; La Co, Slic-Tite; or equal.

2. Fastener Material Group Numbering System

a. Flange fasteners shall conform to the following material standards and shall be categorized within the Fastener Material Schedule Groups as indicated:

1) Material Group C1 (Carbon steel): ASTM A307 Grade B bolts, ASTM A563 Grade B nuts with ASTM F436 washers

2) Material Group C2 (Carbon steel): ASTM A193 Grade B7 bolts, ASTM A194 Grade 2H nuts with ASTM F436 washers

3) Material Group S1 (316 SS): ASTM A193, Grade B8M bolts, ASTM A194 Grade 8M nuts with Type 316 SS plain washers.

4) Material Group S2 (304 SS): ASTM A193, Grade B8 bolts, ASTM A194 Grade 8F nuts with Type 304 SS plain washers.

5) Material Group S3 (Hastelloy C-276): ASTM F468 N10276 bolts ASTM F467 N10276 nuts with type Hastelloy plain washers.

3. Fastener Material Group Numbers used in Non-Corrosive Service Applications

a. AWWA C115 ductile iron flanges - Material Group C1

b. AWWA C207 steel flanges - Material Group C2

c. ASME B31 group piping flanges – Material Group C2

d. Non-metallic pipe flanges - Material Group S1

e. Stainless steel pipe flanges and all others not listed above - Material Group S1

f. Where mating flanges are of different flange material standards and the specified Fastener Material Groups are in conflict, then fasteners of the higher grade shall be utilized unless otherwise indicated. For the purpose of this requirement, the Material Groups in order of decreasing grade shall be S1, C2, C1. Provide insulating flange sets for dissimilar metal flanged piping to electrically isolate the dissimilar piping.

g. Where gaskets of Teflon or Viton-A are required, fasteners of Material Group C2 shall be utilized for all C1 flange standards.

4. Fastener Material Group Numbers used in Corrosive Service Applications

a. All Flange fasteners shall be of Material Group S1 unless S2 and S3 are otherwise indicated on the drawings.

F. Insulating Flanges

1. Insulated flanges shall be provided with bolt holes 1/4-in diameter greater than the bolt diameter.

G. Insulating Flange Sets

1. In order to prevent corrosion, insulating flange sets shall be furnished on all piping connections where two dissimilar metals are to be connected. Each insulating flange set shall consist of an insulating gasket, insulating sleeves and washers, and a steel washer.

2. For bolt diameters 1-1/2-in or smaller, insulating sleeves and washers shall be one piece and shall be made of minlon or approved equal.

3. For bolt diameters larger than 1-1/2-in, insulating sleeves and washers shall be 2-piece and shall be made of polyethylene or phenolic material.

4. Insulating flange sets materials used for fluids other than general water and wastewater shall be made of materials compatible with the fluid services.

5. Insulating gaskets shall be full-face.

H. Insulating Flange Manufacturer, or Equal

1. JM Red Devil, Type E

2. Fluid Sealing Products, Inc.

3. Enpro Industries, Inc. (GPT)

I. Flange Gaskets

1. Gaskets for flanged joints used in general water and wastewater service shall be full faced type in accordance with AWWA C207, suitable for the flange pressure rating and design temperatures and the pH of the fluid being contained.

2. Blind flanges shall be provided with gaskets covering the entire inside face of the blind flange and shall be cemented to the blind flange.

3. Ring gaskets will not be accepted unless otherwise indicated.

4. Unless otherwise indicated, flange gaskets up to 150 psi shall be EPDM sheet material, NSF 61 approved, Garlock, Style 98206-U (unbranded), or similar products from John Crane, or equal.

5. Unless otherwise indicated, flange gaskets up to 500 psi shall be aramid fiber with rubber binder material, NSF 61 approved, Garlock, Style 3760-U (unbranded), or similar products from John Crane, or equal.

6. Gaskets for flanged joints used in water with chloramines shall be Teflon material, NSF 61 approved, Garlock, Gylon Style 3505, or similar products from John Crane, or equal.

7. Gaskets for flanged joints used in water with ozone shall be Teflon material, NSF 61 approved, Garlock, Gylon, Style 3504, or similar products from John Crane, or equal.

8. Gaskets for flanged joints used in cryogenic oxygen (LOX and GOX) service shall be Teflon material, Garlock Gylon, Style 3502 and 3503 or similar products from John Crane, or equal.

9. Gaskets for flanged joints in PVC and CPVC piping used in general water and wastewater service shall be NSF 61 approved, full-faced, 1/8-in thick, and made of fluoroelastomer having a durometer hardness of 50 to 70. Gaskets for pipe sizes up to 24-in and 150 psi shall be Garlock Style XP or similar products from John Crane, or equal.

10. When the mating flange has a raised face, provide stainless steel flat ring gasket filler between the PVC flange and gasket and the adjacent flange.

11. Gaskets for flanged joints used in chemicals, hot air, ozone gas, solvents, hydrocarbons, steam, chlorine and other fluids shall be made of materials compatible with the service, pressure, and temperature. Consult gasket Manufacturer for recommended gasket material.

2.03 PIPE THREADS

A. Pipe threads shall be in conformance with ASME B1.20.1 - Pipe Threads, General Purpose (inch), and be made up with Teflon tape unless otherwise indicated.

B. Unless otherwise indicated, use metal FNPT and plastic MNPT for threaded pipe connections between metal and plastic pipes.

2.04 THREADED INSULATING CONNECTIONS

A. General

1. Threaded insulating bushings, unions, or couplings, as appropriate, shall be furnished for joining threaded pipes of dissimilar metals and for piping systems where corrosion control and cathodic protection are involved.

B. Materials

1. Threaded insulating connections shall be constructed of nylon, Teflon, polycarbonate, polyethylene, or other non-conductive materials, and shall have ratings and properties to suit the service and loading conditions.

2.05 MODULAR MECHANICAL SEALS FOR PIPING PENETRATIONS

A. Where indicated and where required in order to prevent flow of water or air, the passages of piping through wall sleeves and cored openings shall be sealed with modular interlocking link mechanical closures.

B. Individual links shall be constructed of EPDM rubber, be suitable for temperatures between minus 40 and plus 250 degrees F and be shaped to fill the annular space between the outside of the pipe and the inside of the wall sleeve or cored opening.

C. Assemble the links using Type 316 stainless steel bolts and nuts to form a continuous rubber belt around the pipe.

D. Pressure plates under each bolt and nut shall be fabricated of a corrosion-resistant composite material.

E. After the seal assembly is positioned in the sleeve, tighten the bolts against the pressure plates to expand the rubber links and form the watertight seal.

F. Sizing and installation of sleeves and assemblies shall be in accordance with the manufacturer's recommendations.

G. Modular Mechanical Seals Manufacturer, or Equal

1. EnPro Industries Company (GPT), Link-Seal

2. Proco Products, Inc., Pen-Seal

2.06 AIR AND GAS TRAPS

A. Air and gas pipes shall slope to low points and shall be provided with drip legs, shut-off valves, strainers, and traps.

B. Pipe the traps to the nearest drain.

C. Air and gas traps shall be not less than Class150 iron body float-type, with a copper or stainless-steel float.

D. Bracket, lever, and pins shall be constructed of stainless steel.

E. Drain traps shall be provided with threaded connections.

F. Air and Gas Traps Manufacturer, or Equal

1. Armstrong International, Inc.

2. Spirax Sarco, Inc.

2.07 PIPE INSULATION

A. Hot and cold liquid piping, flues, and engine exhaust piping shall be insulated as indicated and in accordance with the requirements of Section 43 07 00 – Process Piping and Equipment Insulation.

B. No unprotected hot piping shall be within reach of operating personnel or other persons.

2.08 HEAT TRACING

A. Pipes subject to freezing shall be protected by heat tracing in accordance with the requirements of Section 26 05 50 – Electric Heat Tracing.

B. Heat traced pipe shall be insulated as indicated and in accordance with the requirements of Section 43 07 00 – Process Piping and Equipment Insulation

PART 3 -- EXECUTION

3.01 GENERAL

A. This section specifies the general installation requirements for piping, valves, and related items and shall be installed in accordance with the manufacturer's technical data and printed instructions. Specific piping materials, systems, appurtenances, and related installation and testing requirements are specified in related sections of Divisions 01, 33, and 40, and as noted on the Drawings, Pipe and Valve Schedules.

B. Piping shall be installed in a neat and workmanlike manner, properly aligned and cut from measurements taken at the Site to avoid interferences with structural members, architectural features, openings, and equipment. Exposed pipes shall afford maximum headroom and access to equipment, and where necessary piping shall be installed with sufficient slopes for venting or drainage of liquids and condensate to low points.

C. Contractor shall obtain the assistance of the pipe manufacturer to instruct the pipe fitters in the correct installation and support of the piping system. Valves and flanges attached to the pipe shall be provided with adequate supports.

D. Lined Piping Systems

1. The lining manufacturer shall take full responsibility for the complete, final product and its application.

2. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

3.02 INSTALLATION

A. Installation shall be free from defects. Prior to installation, each pipe length shall be carefully inspected, be flushed clean of any debris or dust, and be straightened if not true straight. Ends of threaded pipes shall be reamed and filed smooth. Groove ends shall be clean and free from indentations, projections, and roll marks in the area from the pipe end to the groove. Fittings shall be equally cleaned before assembly.

B. Building gravity flow plumbing pipes shall be installed in a neat and workmanlike manner, in accordance with the prevailing plumbing and building codes. Pipes shall have the required slopes for proper drainage. Pipe locations inside buildings shall be coordinated with the rest of the Work to avoid interferences and to provide sufficient headroom. Installations shall be acceptable to the local plumbing inspector.

C. Supports and Anchors: Piping supports, thrust, and seismic restraints shall be provided where shown on the Drawing or were determined to be required in according to Section 40 05 07 - Pipe Supports. Where necessary to avoid stress on equipment or structural members, the pipe shall be anchored or harnessed. Expansion joints and guides shall compensate for pipe expansion due to temperature differences. Pipe shall be firmly supported with fabricated or commercial hangers or supports.

D. Piping Joints: Pipe joints requirements shall conform to the applicable piping sections of Division 33 and Division 40.

1. Threaded Joints: Pipe threads shall be full and cleanly cut with sharp dies. Not more than 3 threads shall remain exposed after installation.

2. Welded Joints: Welded joints shall conform to the specifications and recommendations of ASME B31.1 - Power Piping. Welding shall be done by skilled and qualified welders. Pipe surface residues, oxides, and heat stains are to be removed from a field weld and the affected areas adjacent by the use of stainless-steel wire brushes. For alloy and stainless-steel pipe, the post welding surfaces shall be cleaned with a pickle agent such as nitric/hydrofluoric acid solutions or pickle paste or equal, then complete removal of the agent by wash the surface thoroughly with clean water.

3. Flange Joints: Flanged joints shall be made with gaskets with bolts and nuts as specified. Care shall be taken not to over-torque the bolts, in accordance with the manufacturer's written recommendations.

4. Fusion-Welded Joints: Fusion-welded joints shall be made with the manufacturer's recommended equipment on clean, dry pipe ends. The joints shall be made up at the recommended ambient temperatures, to the pipe manufacturer's written recommendations. The pipe supplier shall be consulted to obtain machinery and expertise for the joining by fusion welded of pipe and fittings. No pipe or fittings shall be joined by fusion by any of the Contractor's personnel unless they are adequately trained and qualified in the techniques involved. Butt fusion joining shall yield a joint strength equal to or greater than the tensile strength of the pipe. Socket fusion, extrusion welding and hot gas welding shall not be used for field connections.

5. Brazed and Soldered Joints: Brazed and soldered joints shall conform to the manufacturer’s recommendations and to the specifications and recommendations

of ASME B31.1 - Power Piping. Brazing shall be done by skilled and qualified welders. Prior to the application of flux, the ends of tubes shall be thoroughly dried and cleaned

6. Grooved Joints: Grooves for grooved couplings and fittings shall be made with specially designed grooving tools to the manufacturer's recommendations and conform to AWWA C606 – Joints, Grooved and Shouldered Type. Grooves shall be clean and sharp without flaws, and the pipe ends shall be accurately cut at 90 degrees to the pipe axis.

7. Push On Joints: Push on joints and gasket installation shall be in accordance with the manufacturer's recommendations and lubricants. Pipe ends shall be beveled to facilitate assembly. Lubricants shall be suitable for potable water service and shall be kept clean in closed containers.

8. Solvent-Welded Joints: Solvent-welded joints shall be made with fresh primer and solvent cement on clean, dry pipe ends. The primer and cement cans shall be kept always closed and the joints shall be made up at the recommended ambient temperatures, to the pipe or cement manufacturer's written recommendations. PVC socket connections shall be joined with PVC cement conforming to ASTM D2564 Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC). CPVC socket connections shall be joined with CPVC solvent cement conforming to ASTM F493. For chemical service applications, solvent cement shall be formulated and labeled for use on that chemical.

9. Adhesive Joints: Adhesive joints shall be made with freshly-mixed 2-part epoxy on clean, dry pipe ends per pipe manufacturer recommendations. The joints shall be made up at the recommended ambient temperatures, to the pipe or adhesive manufacturer's written recommendations. Pipe ends shall be inserted to the full depth of the socket.

E. Valves and Unions: Unless otherwise indicated, connections to fixtures, groups of fixtures and equipment shall be provided with a shutoff valve and union, unless the valve has flanged ends. Unions shall be provided at threaded valves, equipment, and other devices requiring occasional removal or disconnection.

F. Branch Connections: Branch connections in horizontal runs of air and gas piping shall be made from the top of the pipe, to avoid drainage of condensate into the equipment. Unless otherwise indicated for threaded pipe connections between metal and plastic pipes, use metal FNPT and plastic MNPT.

1. Pipe ends and joints of lined pipes at threaded flanges shall be epoxy-coated in order to assure continuous protection.

G. Isolation Joints / Dielectric Protection: Provide electrically isolate connections between dissimilar metal piping connections. Electrical checks shall be made to assure no contact is made between dissimilar metal piping elements.

1. Use dielectric couplings specially designed for the prevention of galvanic reaction between dissimilar metals.

2. For flanged connections, use stainless steel bolts with isolation bushings, washers, and full-face flange gaskets.

H. Core Drilling: Where core drilling is required for pipes passing through existing concrete, core drilling locations shall be determined by radiograph of concrete construction in order to avoid damage to embedded raceways and reinforcing bars.

I. Coating: Exposed pipes shall be coated with a finish coat to the pipe manufacturer's standard protective coating, with the manufacturer's recommended prime coat and a finish coat in accordance with Section 09 96 00.10 – High-Performance Coatings.

J. Low points in piping systems and drip legs in steam, gas, and air systems shall have drainage valves.

K. Care shall be taken to ensure that piping flanges, mechanical-type couplings, sleeve-type couplings, flexible connectors, and expansion joints are properly installed as follows:

1. Gasket surfaces shall be carefully cleaned and inspected prior to making up the connection. Gasket shall be centered properly on the contact surfaces.

2. Connections shall be installed to prevent inducing stress to the piping system or the equipment to which the piping is connected.

3. Contact surfaces for flanges, couplings, and piping ends shall be aligned parallel, concentric, and square to each axis at the piping connections.

4. Flange Bolts

a. Flange bolts shall be initially hand-tightened with the piping connections properly aligned.

b. Bolts shall be tightened with a torque wrench in a staggered sequence to the recommended torque for the applicable piping material per AWWA or manufacturer's recommendation. Care shall be taken to avoid over-torquing the bolts especially on plastic flanged joints.

c. Harness, thrust restraint, and tie rod bolts used for sleeve couplings, flange coupling adapters, or flexible joints shall be tightened gradually and equally at diametrically opposite sides until snug, in order to prevent misalignment and to ensure that all studs carry equal loads.

d. In order to prevent induced stress or misalignment, do not over-torque connections to adjoining pump or equipment. Flanges shall not be deformed nor cracked.

3.03 INSPECTION

A. After completion of the Work, cuttings, joining and wrapping materials, and other scattered debris shall be removed from the Site. The entire piping system shall be in a clean and functional condition.

B. Inspection: Finished installations shall be carefully inspected for proper joints and supports, interferences, and damage to pipe, fittings, and coating. Temporary plugs and covers shall be removed from openings and floor drains. Defective Work shall be repaired to the satisfaction of the field engineer or plumbing inspector.

3.04 FIELD TESTING FOR PRESSURE PIPING

A. Prior to enclosure or burying, piping systems shall be pressure tested as required in the Piping Schedule for a period of not less than two hours without exceeding the tolerances listed in the Piping Schedule. Where no pressures are indicated, the pipes shall be subject to 1-1/2 times the maximum working pressure. The Contractor shall furnish test equipment, labor, materials, and devices as part of the Work. For additional testing requirements, refer to Section 33 05 05 - Pressure Pipe Testing and Disinfection.

B. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Leaks shall be repaired, and the system shall be re-tested until no leaks are found.

3.05 FIELD TESTING FOR GRAVITY PLUMBING PIPING

A. Prior to enclosure or burying, drains and vents shall be tested in the presence of the local plumbing inspector and the Engineer for a period of not less than one hour, or as requested by the plumbing inspector if the request is more stringent. The Contractor shall furnish test equipment, labor, material, and devices as part of the Work. Defective Work shall be repaired to the satisfaction of the plumbing inspector, and the piping shall be re-tested until no leaks are found.

B. Leakage may be determined by loss of pressure, soap solution, chemical indicator, or other positive and accurate method. Fixtures, devices, or other accessories which are to be connected to the lines and which would be damaged if subjected to the test pressure shall be disconnected and ends of the branch lines plugged or capped as required during the testing procedures.

C. Testing and defective Work shall be repaired to the satisfaction of the plumbing inspector.

END OF SECTION

SECTION 40 05 02 – PIPING IDENTIFICATION

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide identification for the piping and valves, complete and in place, in accordance with the Contract Documents.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
09 96 00.10	High-Performance Coatings

C. Commercial Standards

American Society of Mechanical Engineers (ASME)	
ASME A13.1	Scheme for the Identification of Piping Systems

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Provide a list of the suggested wording for each pipe label and valve tag, prior to fabrication.

C. Samples

1. Sample of each type of identification device.

2. Sample of each proposed color required by the pipe color schedule.

PART 2 -- PRODUCTS

2.01 EXPOSED PIPING OR ABOVE GROUND PIPING IDENTIFICATION

A. Pipe markers, type as indicated below, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements.

1. Marker Type

a. Snap Around: Vinyl or polyester sheet with UV- resistant ink, pre-shaped and sized to tightly curl around the pipe and remain in position.

b. Adhesive: Vinyl or polyester sheet with UV- resistant ink, shaped similar to pipe curvature and coated with pressure sensitive adhesive.

c. Stencil: Lettering painted directly on surface of pipe inside color coded marker area.

2. Marker Area: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

3. Lettering: Sized per pipe size according to ASME A13.1 and conforming to the color codes in the Identification Colors table below.

4. Arrows: At least one arrow at each marker area, showing direction of flow.

B. Pipe 1-inch diameter and smaller or pipe not suitable for the marker type(s) listed above shall be identified with aluminum or stainless-steel pipe identification tags with stamped-in ¼" high identification lettering. The Contractor shall procure tags that include pipe identification indicated in the Contract Drawings.

C. Manufacturer or Equal

1. **Seton Identification Products**, Opti Code Pipe Markers (adhesive type)

2. **Grainger, Inc.** (adhesive, snap around)

3. **Marking Services, Inc.** (adhesive, snap around)

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground Warning Tape

1. Material:

a. Polyethylene tape or polyolefin film. The material and ink shall be chemically inert and shall not degrade when exposed to acids, alkalis and other destructive substances commonly found in soil.

b. 6" wide tape with a minimum 4 mil thickness.

c. Message: "CAUTION, LINE BURIED BELOW" with the name of the fluid service in black lettering on a colored background.

1) Water: Blue

2) Sewer: Green

3) Gas and other services: Yellow

4) Other services: colors as approved by the Owner.

2. Manufacturer, or Equal

a. Reef Industries, Inc.

b. Seton Identification Products

c. T. Christy Enterprises, Inc.

B. Tracer Wire

1. Material:

a. Solid copper conductor with 30 mil HMWPE.

b. 10 gauge or thicker wire.

2. Manufacturer, or Equal

a. **Kris-Tech Wire**

b. **Corrpro Companies, Inc.**

C. Witness Markers

1. Material:

a. UV resistant glass fiber and resin reinforced thermosetting composite material.

b. Constructed as a single pipe with pointer at the bottom end.

c. Message of the markers “CAUTION, LINE BURIED BELOW” with the name of the fluid service, and the following information:

1) Phone number for underground service alert.

2) Phone number for Owner in case of emergency.

3) Application station number and offset information if marker is not directly over the pipe.

4) Name of buried appurtenance or fitting if applicable.

2. Manufacturers, or Equal

a. **Carsonite®** Composite Utility Marker

b. Berntsen International, Inc.

2.03 EXISTING IDENTIFICATION SYSTEMS

A. In installations where existing piping identification systems have been established, the Contractor shall follow the existing system. Where existing identification systems are incomplete, utilize the existing system as far as practical and supplement with the system indicated herein.

2.04 IDENTIFICATION OF VALVES AND SHORT PIPE LENGTHS

A. Valves and sections of pipe that are too short to be identified with markers and arrows shall be identified with metal or plastic tags.

B. Metal tags shall be stainless steel with embossed lettering. Plastic tags shall be solid black plastic laminate with white embossed letters. Tags shall be designed to be firmly attached to the valves or short pipes or to the structure immediately adjacent to the valves or short pipes.

C. Wording on valve tags shall describe the exact function of each valve (e.g., "HWR-BALANCING," "CLS THROTTLING", "RAS-PUMP SHUT-OFF," etc.) and include the valve number as indicated in the Contract Drawings. Wording on small pipes shall describe the contents of the pipe.

D. The Contractor shall procure tags that include valve numbers indicated in the Contract Drawings.

2.05 PIPE COATING:

A. Unless otherwise indicated, pipe coating shall be in conformance with Section 09 96 00.10 – High-Performance Coatings.

PART 3 -- EXECUTION

3.01 GENERAL

A. Markers and identification tags shall be installed in accordance with the manufacturer's printed instructions and shall be neat and uniform in appearance. Tags and markers shall be readily visible from all normal working locations.

3.02 VALVE TAGS

A. Valve tags shall be permanently attached to the valve or structure by means of 2 stainless steel bolts or screws.

3.03 MARKER LOCATIONS

A. Each pipe shall be marked at:

1. Intervals of 20-feet in straight runs.

2. At least once in every room.

3. Within 2 feet of turns, elbows, and valves.

4. On the upstream side of tees, branches, and other distribution points.

5. On both sides of walls and floors through which the piping passes.

Color Combinations	New Standard ASME A13.1-2007	Old Standard ASME A13.1-1996 (R2002)
White on Red	Fire quenching fluids	Fire quenching materials
Black on Orange	Toxic and corrosive fluids	
Black on Yellow	Flammable fluids	Hazardous Materials Flammable or explosive Chemically active or toxic Extreme temperatures or pressures Radioactive
White on Brown	Combustible fluids	
White on Green	Potable, cooling, boiler feed, and other water	Low hazard materials
White on Blue	Compressed air	Low hazard gases
White on Purple	User defined	
Black on White	User defined	
White on Gray	User defined	
White on Black	User defined	

3.04 IDENTIFICATION COLORS

A. Conform to the following color codes.

Pipe Contents		Marker Color	Letter Color
Symbol	Service		
ACH	Aluminum Chlorohydrate	blue	white
BR	Brine	orange	black
CIPD	Clean-in-Place Drain	orange	black
CIPR	Clean-in-Place Return	orange	black
CIPS	Clean-in-Place Supply	orange	black
CTA	Citric Acid	orange	black
CTS	Calcium Thiosulfate	orange	black

Pipe Contents		Marker Color	Letter Color
Symbol	**Service**		
DR	Drain	green	white
EFMD	Enhanced Flux Maintenance	orange	black
FM	Force Main	green	white
FT	Filtrate	green	white
FW	Finished Water	green	white
LSP	Landscaping Sprinkler System	green	white
MF	Membrane Feed	green	white
NW	Neutralized Waste	orange	black
PA	Plant Air	blue	black
PO	Plant Overflow	green	white
PW	Potable Water	green	white
RF	Reverse Flow	green	white
RW	Raw Water	green	white
SAM	Sample	green	white
SAN	Sanitary Waste	green	white
SBW	Strainer Backwash Waste	green	white
SDH	Sodium Hydroxide (Caustic Soda)	orange	black
SDR	Storm Drain	green	white
SHC	Sodium Hypochlorite	orange	black
SP	Spare Chemical	orange	black
SW	Softened Water	green	white
UW	Utility Water (Non-Potable Water)	green	white
VT	Vent	blue	white
XR	Excess Recirculation	green	white

END OF SECTION

SECTION 40 05 06 – COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide pipe couplings indicated, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping General apply to the Work of this Section

C. The provisions of this Section shall apply to piping in Divisions 33 and 40, and on the Drawings.

D. The couplings, adapters and joints shall be provided with restraining devices to restrict pipe axial movement. Where the restraining devices and/or details are not indicated on the Drawings, it is the Contractor's responsibility to provide the devices/details necessary to restraint the piping system.

E. The Items specified in this section include the following:

1. Groove Couplings
2. Sleeve Couplings
3. Flanged Coupling Adapters
4. Dismantling Joints
5. Expansion Joints
6. Flexible Connectors
7. Transition Couplings.
8. Quick Disconnect Couplings
9. Tapping Sleeves
10. Miscellaneous Adapters

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Shop Drawings shall contain the following information:

1. Product submittals and shall be specifically identified with the applicable style or series designation, pressure rating and restraint system if applicable.
2. Couplings schedule or layout indicating where the couplings will be installed.

3. Expansion Joints: Submit detailed calculations and manufacturer's Shop Drawings of proposed expansion joints, piping layouts, and guides, including information on materials, temperature, and pressure ratings

4. Flexible Connectors: Submit pressure and thermal expansion calculations

C. Certifications

1. Necessary certificates, test reports, and affidavits of compliance shall be obtained by the Contractor.

1.03 MATERIAL DELIVERY, STORAGE, AND PROTECTION

A. Piping couplings, adapters and joints accessories shall be delivered in a clean and undamaged condition and stored off the ground for protection against oxidation caused by ground contact.

B. Defective or damaged materials shall be replaced with new materials.

1.04 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See 01 33 00 for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
09 96 00.10	High-Performance Coatings
40 05 01	Piping General

C. Reference Standards

American Iron and Steel Institute (AISI)	
AISI 1012	Carbon Steel
ASTM A512	Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing
ASTM A513	Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing
ASTM A 576	Steel Bars, Carbon, Hot Wrought, Special Quality
American Water Works Association (AWWA)	
AWWA C207	Standard for Steel Pipe Flanges for Waterworks Service, Sizes 4 in. through 144 in. (100 mm through 3600 mm)
AWWA C219	Bolted Sleeve-Type Couplings for Plain-End Pipe
AWWA C606	Grooved and Shouldered Joints
AWWA M11	Steel Pipe: A Guide for Design and Installation

PART 2 -- PRODUCTS

2.01 GENERAL

A. Extent of Work

1. Piping couplings, adapters, joints and accessories shall be provided in accordance with the requirements of the applicable Sections of Divisions 33 and 40 and as indicated.

2. The Contractor shall not be allowed to substitute any other type of coupling in lieu of the couplings as specified herein unless approved by the Engineer.

3. The Contractor shall assign the responsibility to the coupling manufacturer to review the piping connection to the equipment and submit any modifications to the Engineer for review.

B. Pressure Rating

1. Couplings, adapters, and joints shall be designed for the pressure as defined in respective pipe sections, or as indicated on the Piping Schedule, whichever is greater.

C. Seals

1. Seal elastomer materials shall be selected to be compatible with the fluid service, pressure, and temperature. They shall be composed of elastomeric-compound material that will not deteriorate from age under normal storage or use conditions.

2. Where couplings are used in water containing dissolved ozone residual or chloramines, seal material shall be Viton-A.

D. Coating

1. Couplings shall be lined and coated at the factory, unless otherwise indicated.

2. Coating shall be in accordance with the Section 09 96 00.10 – High-Performance Coatings, unless otherwise indicated.

2.02 GROOVED TYPE COUPLINGS

A. General

1. Provide cast grooved type couplings where indicated, conforming to the requirements of AWWA C606 - Grooved and Shouldered Joints.

2. Grooved or banded piping shall conform to the coupling manufacturer's recommendations to suit the highest expected pressure.

a. If grooved connections are used, the remaining thickness of pipe material after grooving shall be adequate to carry the load imparted to the joint. Joints for thin wall pipes shall be banded or welded with a collared end to fit coupling.

b. Rolled pipe ends are not acceptable as a means of connection for metallic piping.

3. Equipment connections with mechanical-type couplings shall be provided with rigid grooved couplings or flexible type coupling with harness in sizes where rigid type couplings are not available, unless thrust restraint is provided by other means.

4. Couplings shall be electrically bonded.

5. For uniformity and compatibility of the piping components; grooving tools, grooved fittings, couplings, and valves shall be furnished by the same manufacturer as the coupling.

B. Grooved Type Couplings Manufacturer, or Equal

1. Grooved couplings for ductile iron piping shall be provided with flush seal gaskets.

a. **Victaulic Company**, Style 31 (flexible or rigid)

b. **Gustin-Bacon** (banded or grooved)

2. Grooved couplings for steel piping

a. **Victaulic Company**, Style 177 / 77 / W77 (grooved, flexible, or rigid)

b. **Victaulic Company**, Style 107H / 07 / W07 or HP-70 (grooved, rigid)

c. **Gustin-Bacon** (banded or grooved)

3. Grooved couplings for stainless steel piping

a. **Victaulic Company**, Style 489 (rigid)

b. **Victaulic Company**, Style 77S (flexible)

c. **Gustin-Bacon** (banded or grooved)

2.03 SLEEVE COUPLINGS

A. General

1. Provide sleeve couplings specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Sleeve couplings shall be in accordance with AWWA C219 - Standard for Bolted Sleeve-Type Couplings for Plain-End Pipe.

2. Couplings shall be constructed without pipe stop.

3. The middle ring shall be at least the same wall thickness as the pipe to which the coupling is connected and not less than 1/4-inch thick.

4. If the strength of the middle ring material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. For standard sleeve couplings, the coupling shall be either 5 or 7 inches long for pipe diameters up to and including 30-inch and 10 inches long for pipe diameters greater than 30-inch. For long sleeve couplings, the coupling shall be 16 inches long for all pipe diameters.

6. The followers shall be single-piece contoured mill sections welded and cold-expanded as required for the middle rings and of sufficient strength to accommodate the number of bolts necessary to obtain adequate gasket pressures without excessive rolling.

C. Insulating Sleeve Couplings

1. Where insulating couplings are required, both ends of the coupling shall be provided with a wedge-shaped gasket which assembles over a sleeve of an insulating compound material compatible with the fluid service in order to obtain insulation of coupling metal parts from the pipe.

D. Sleeve-Type Couplings Manufacturer, or Equal

1. **World Wide Metric, Inc**. (Dresser), Style 38

2. **Ford Meter Box Company, Inc.**, Style FC1 or FC3

3. **Smith-Blair, Inc.**, Style 411

2.04 FLANGED COUPLING ADAPTERS

A. Provide flanged coupling adapters specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or ASTM A513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012 – Carbon Steel.

C. Flanged Couplings Adapter Manufacturer, or Equal

1. **Smith-Blair, Inc.**, Model 913

2. **Dresser®**, Style 128-W

3. **JCM Industries, Inc.**, Model 303

2.05 DISMANTLING JOINTS

A. Provide dismantling joints products specifically designed suitable for the fluid service and pressure rating.

B. Construction

1. Coupling bodies shall be fabricated from steel, ASTM A 512 - Cold-Drawn Butt-Weld Carbon Steel Mechanical Tubing or A 513 - Electric-Resistance Welded Carbon and Alloy Steel Mechanical Tubing.

2. Provide flanges in conformance with AWWA C207.

3. The body shall be at least the same wall thickness as the pipe to which the coupling is connected, but not less than 1/4 inch thick.

4. If the strength of the body material is less than the strength of the pipe material, the thickness of the middle ring shall be increased to have the same strength as the pipe.

5. The follower flange shall be fabricated from steel, ASTM A 576 - Steel Bars, Carbon, Hot Wrought, Special Quality or AISI C1012 – Carbon Stee.

C. Dismantling Joints Manufacturer, or Equal

1. **Smith-Blair, Inc.**, Model 975

2. **Dresser®**, Style 131

3. **JCM Industries, Inc.**, Model 309

2.06 EXPANSION JOINTS

A. Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures, accomplished with expansion loops, bellow-type expansion joints, or sliding-type expansion joints.

B. Expansion joints shall be provided with flanged ends and constructed of stainless steel, Monel, rubber, or other materials best suited for each individual service. Where expansion joints are used in water containing dissolved ozone residual or chloramines, provide Type 316 stainless-steel expansion joints.

C. Where bellows-type expansion joints are mounted near the suction nozzle of the pump, a stainless-steel internal liner shall be provided to minimize turbulence as the flow passes through the arches of the bellows.

D. Expansion joints for Plastic Tanks

1. Expansion joints for piping connections to polyethylene tanks nozzles shall be provided by the tank manufacturer, selected for the fluid service, and sized for up to 4% tank expansion or movement as required by the tank manufacturer. Fastener hardware shall be of Type 316 stainless steel construction.

2. Expansion joints for other plastic tanks shall be constructed of molded PTFE with at least two convolutions and flanged joints. Flanges shall be ductile iron with Type 316 stainless steel bolts and nuts. Flexible connectors shall be **Proco Series 442 molded expansion joint, or equal**.

2.07 FLEXIBLE CONNECTORS

A. Low-Temperature

1. Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment, and where indicated.

2. Flexible connectors for service temperatures up to 180 degrees F shall be flanged-reinforced neoprene or butyl spools, rated for a working pressure of 40 to 150 psig, or reinforced flanged duck and rubber, as best suited for the application.

3. Flexible connectors for service temperatures above 180 degrees F shall be flanged, braided stainless steel spools with inner, annular, corrugated stainless steel hose, rated for a minimum 150-psig working pressure, unless otherwise recommended by the equipment manufacturer.

4. The connectors shall be a minimum of 9 inches long and provided with face-to-face flanges, unless otherwise indicated.

5. The final material selection shall be approved by the manufacturer.

B. High-Temperature (temperature exceeding 250 degree F (120 degree C)

1. Install flexible connectors in engine exhaust piping and where indicated.

2. Connectors shall be sufficient to compensate for thermal expansion and contraction and to isolate vibration between the engine and the exhaust piping system.

3. Connectors shall be stainless steel bellows-type, flanged, and rated for minimum 150 psig, 2000 degrees F.

2.08 TRANSITION COUPLINGS

A. Provide transition-coupling products specifically designed suitable for the fluid service and manufactured for the piping applications.

B. The transition couplings shall have function and design similar to the flexible couplings, joint and flanged coupling adapters for connecting piping having different outside diameters.

2.09 QUICK DISCONNECT COUPLINGS

A. Quick disconnect couplings shall be of the cam lock type (cam and groove type) consisting of a male adapter conforming to Specification MIL A-A-59326A. Male adapters shall be designed to receive a female coupler without requiring threading, bolting, or tools. Connections shall remain tight and leak proof up to full system pressures.

B. Each adapter shall be furnished with a dust cap complete with an 18-in long security chain of corrosion resistant material.

C. Unless otherwise indicated, the quick disconnect couplings shall be flanged connection to piping and materials shall be Type 316 stainless steel.

D. Quick connect couplings shall be as manufactured by **LMC-Couplings**; **Dover Corporation**; **Ever-Tite Coupling Products**; or equal.

2.10 TAPPING SLEEVES

A. Provide tapping sleeve products specifically designed suitable for the fluid service and manufactured for the piping applications

B. Unless otherwise indicated, the tapping sleeves shall be of full circumference band with flanged outlet connection sized to ANSI class 150. Material of construction for the body and fastener shall be stainless steel.

C. Gasket material: Nitrile (Buna-N) or EPDM.

D. Tapping sleeves shall be as manufactured by **Smith-Blair Inc.**; **Romac Industries Inc.**; **Dresser®**, or equal.

2.11 MISCELLANEOUS ADAPTERS

A. A special pipe adapter may be required to provide proper connection between different type of pipes and/or fittings. The adapter may be indicated on the Drawing with the pipe type or equipment. However, it is the Contractor's responsibility to ensure proper connection between various type of pipes and pipe appurtenances. Provide adapters as required whether specifically indicated or not.

B. Provide piping adapter products specifically designed suitable for the fluid service and manufactured for the piping applications.

PART 3 -- EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 40 05 01 - Piping General.

B. The Contractor shall have the coupling manufacturer's service representative verify the correct choice and application of couplings and gaskets, and the workmanship, to assure a correct installation.

C. The Contractor shall assign the responsibility to the couplings manufacturer to review the piping connection to the couplings and submit any modifications to the Engineer for review.

3.02 INSTALLATION

A. Where couplings are shown to connect piping to mechanical equipment such as pumps, compressors, and blowers, the piping shall be aligned with the equipment point of connection and shall be perpendicular to the axis of the flange or fitting for which the piping is to be connected.

B. The couplings or the piping shall not impose excessive stress to the equipment connection to cause misalignment of the equipment.

C. Restrained Joints on couplings, adapters, and joints

1. Couplings, adapters, and joints on pressure lines shall be harnessed unless thrust restraint is provided by other means.

2. Harnesses shall be designed by the pipe manufacturer in accordance with AWWA M11, or as indicated.

3. Harness sets shall be designed for the maximum test pressure of the pipe in which they are installed.

4. Where harness sets are installed near the suction and discharge of the pump, harness bolts shall have zero elongation in order to prevent misalignment of the pump imparted by the thrust within the piping system.

5. Other means of restraining the coupling such as set screws on piping will not be accepted.

END OF SECTION

SECTION 40 05 07 – PIPE SUPPORTS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide pipe supports, hangers, guides, and anchors, complete and in place, as indicated in accordance with the Contract Documents.

B. Where pipe support systems are not indicated on the Drawings, the Contractor shall design and provide the supports in accordance with this Section. The absence of pipe supports and details on the contract drawings does not relieve the Contractor of responsibility for sizing and providing the pipe supports.

C. The provisions of this Section shall apply to piping in Divisions 33 and 40.

D. The Contractor shall provide supporting devices for supporting and restraining piping as indicated on the Drawings. Where pipe support devices and/or restraining details are not indicated on the Drawings, it is the Contractor's responsibility to develop the details necessary to support and restraint the piping for a complete and functional pipe support system.

E. Seismic and Wind Forces

1. Pipe support details indicated in the Contract Drawings are sized for gravity loads only, and not designed to resist seismic and wind forces.

2. The Contractor shall arrange for the services of a registered professional engineer experienced in pipe support design to design such pipe supports to resist seismic and wind forces.

3. Piping support seismic and wind loads shall be sized in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

1.02 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittals Procedures.

B. Shop Drawings

1. Submit Shop Drawings which shall include the following information:

a. Drawings of pipe supports, hangers, anchors, and guides.

b. Pipe support schedule or layout indicating where the supports will be installed.

c. Calculations for special supports and anchors, stamped and signed by a registered professional engineer in the state where the project is located.

C. Pre-Engineered Metal Building (PEMB) pipe attachment method

1. Submit pipe attachment method per the PEMB manufacturer for all pipe supports and hangers attached to the PEMB.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
05 50 00	Metal Fabrications
09 96 00.10	High-Performance Coatings
40 05 01	Piping General

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASTM International (ASTM)	
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)	
ANSI/MSS SP-58	Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

PART 2 -- PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Code Compliance

1. Piping systems and pipe connections to equipment shall be properly anchored and supported in order to prevent undue deflection, vibration, and dislocation due to seismic events, line pressures, pipe weight, fluid weight, liquid movement, thermal changes, vibration, and probable forces applied during construction as well as stresses on piping, equipment, and structures.

2. Supports and parts thereof shall conform to the requirements of ASME B31.1 - Power Piping – Chapter II, Part 5 -Expansion, Flexibility, and Pipe Supporting Element and design the pipe supporting elements in accordance with the rules of MSS SP-58 -Pipe Hangers and Supports – Materials, Design and Manufacture, except as supplemented or modified in this Section.

3. Supports for plumbing piping shall be in accordance with the latest edition of the applicable plumbing code or local administration requirements.

B. Structural Members

1. Wherever possible, pipes shall be supported from structural members.

2. Where it is necessary to frame structural members between existing members, such supplementary members shall be provided by the Contractor.

3. Supplementary members shall be in accordance with the requirements of the Building Code and the American Institute of Steel Construction and shall be as acceptable to the Engineer.

C. Pipe Hangers

1. Pipe hangers shall be capable of supporting the pipe in operation, allowing free expansion and contraction of the piping, and preventing excessive stress on equipment.

2. Hangers shall have a means of vertical adjustment after erection.

3. Hangers shall be designed to prevent becoming disengaged by any movement of the supported pipe.

4. Hangers subject to shock, seismic disturbances, or thrust imposed by the actuation of safety valves shall include hydraulic shock suppressors.

5. Hanger rods shall be subjected to vertical loading only.

D. Hangers Subject to Lateral or Axial Movement.

1. At hanger locations where lateral or axial movement is anticipated, suitable linkage shall be provided to permit such movement.

2. Where lateral or axial pipe movement is greater than 1/2 inch, or where the hanger rod deflection from the vertical is greater than 4 degrees from the cold-to-hot position of the pipe, the hanger rod and structural attachment shall be offset in such a manner that the rod is vertical in the hot position.

E. Spring-Type Hangers

1. Spring-type pipe hangers shall be provided for piping subject to vibration or vertical expansion and contraction, such as engine exhausts and similar piping.

2. Spring-type hangers shall be sized per the manufacturer's printed recommendations and for the loading conditions encountered.

3. Variable spring supports shall be provided with means to limit misalignment, buckling, eccentric loading, or to prevent overstressing of the spring, and with means to indicate the compression of the spring.

4. Supports shall be capable of accommodating at least 4 times the maximum travel due to thermal expansion.

F. Thermal Expansion

1. Wherever expansion and contraction of piping is expected, a sufficient number of expansion loops or expansion joints shall be provided, together with the necessary rolling or sliding supports, anchors, guides, pivots, and restraints permitting the piping to expand and contract freely away from the anchored points.

2. Components shall be structurally suitable to withstand the imposed loads.

G. Heat Transmission

1. Supports, hangers, anchors, and guides shall be designed and insulated such that excessive heat will not be transmitted to the structure or to other equipment.

H. Riser Supports

1. Where practical, risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping.

I. Freestanding Piping

1. Freestanding pipe connections to equipment such as chemical feeders and pumps shall be firmly attached to support frames fabricated from angles, channels, or I-beams anchored to the structure.

2. Exterior, freestanding overhead piping shall be supported on fabricated pipe stands consisting of pipe columns anchored to concrete footings, or with horizontal, welded steel angles, and U-bolts or clamps securing the pipes.

J. Materials of Construction

1. Pipe support assemblies, including framing, hardware, and anchors, shall be of steel construction, galvanized after fabrication, unless otherwise indicated.

2. Submerged supports, as well as piping, conduits, and equipment in hydraulic structures located two feet above water level, shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel, unless otherwise indicated.

3. Piping in chemical and corrosive service areas shall be supported with support assemblies, including framing, hardware, and anchors constructed of Type 316 stainless steel or FRP, unless otherwise indicated.

4. Corrosive service areas are indicated in section 40 05 01 – Piping General, 1.2 Definitions - Corrosive Service.

K. Point Loads

1. Meters, valves, heavy equipment, and other point loads on PVC, FRP, or other plastic pipes, shall be supported on both sides, according to manufacturer's recommendations, in order to avoid undue pipe stresses and failures.

2. In order to avoid point loads, the supports on PVC, FRP, or other plastic piping shall be equipped with extra wide pipe saddles or galvanized steel shields for

general service and Type 316 stainless steel shields for chemical or corrosive areas.

L. Concrete Anchors

1. Unless otherwise indicated, concrete anchors for pipe supports shall be according to the following table: consult the Engineer for any anchor applications not appearing on the table.

2. Anchor embedment shall be in accordance with the requirements of Section 05 50 00 – Metal Fabrications.

Pipe Support Application	**Type of Concrete Anchor**
New Concrete	Use embedded concrete insert anchors on a grid pattern. Use **Grinnell (Anvil International), Tolco**, or equal.
Existing Concrete	Use non-shrink grouted anchors, expansion anchors, or epoxy anchors. Epoxy anchors are not permitted for vertical hanging applications or where sustained tension is exerted on the anchor. Exceptions: Expansion anchors and epoxy anchors are not permitted for pipe supports subject to vibrating loads. Epoxy anchors are not permitted where the concrete temperature is in excess of 100-degree F or higher than the limiting temperature recommended by the manufacturer.
Vibratory Loads and High-Temperature Conditions	Use non-shrink grouted anchors.

M. Noise Reduction

1. In order to reduce the transmission of noise in piping systems, copper tubes in buildings and structures shall be wrapped with a 2-inch wide strip of rubber fabric or similar suitable material at each pipe support, bracket, clip, or hanger.

2.02 SUPPORT SPACING

A. Supports for piping with the longitudinal axis in approximately a horizontal position shall be spaced to prevent excessive sag, bending, and shear stresses in the piping, with special consideration given where components such as flanges and valves impose concentrated loads.

B. Where pipe spacing are indicated on the Drawings and are referenced to a Standard Detail, that requirement shall take preference over the general requirements of this section.

C. Pipe support spacing shall not exceed the maximum indicated spans. Piping with grooved joint couplings, flexible joints, and bend fittings shall be balanced supported by a minimum of two pipe supports per pipe length, one at near each joint/fitting.

D. For temperatures other than ambient temperatures or those listed, and for other piping materials or wall thicknesses, the pipe support spacings shall be modified in accordance with the pipe manufacturer's recommendations.

E. Vertical supports shall be provided to prevent the pipe from being overstressed from the combination of loading effects.

F. Steel Pipe

1. Where support spacing is not indicated on the Drawings, the Contractor shall use the spacing below.

2. Support Spacing for standard wall or heavier welded steel, stainless steel or alloy steel pipe.

Nominal Pipe Diameter, Inches	**Maximum Span, ft (Water Service)**	**Maximum Span, ft (Gas or Vacuum Service)**
1/2	6	7
3/4 and 1	8	9
1-1/4 to 2	10	12
3	12	14
4	14	15
6	16	18
8 and 10	18	20
12 and 14	20	24
16 and 18	22	26
20 and greater	24	30

G. Ductile Iron Pipe

1. Install supports for ductile iron pipe in accordance with the recommendations of the Ductile Iron Pipe Research Association (DIPRA) Design of Ductile Iron Pipe on Supports.

2. As a minimum, where support spacing is not indicated on the Drawings, the Contractor shall use the spacing indicated in the following schedule:

Nominal Pipe Diameter, inches	Support Configuration
All diameters	two supports per pipe length, with one of the two supports located at a joint

H. Schedule 80 PVC and CPVC Pipe

Nominal Pipe Size, inches	100 °F and below	101 to 120 °F	121 to 140 °F
1	5	3.5	3
1-1/2	5.5	3.5	3.5
2	6	4	3.5
3	7	4.5	4
4	7.5	5	4.5
6	9	6	5
8	9.5	6.5	5.5
10 and larger	10	7	6

I. Other Pipe Materials

1. Support spacing for pipe constructed of other materials shall be based on design temperature and in accordance with the pipe manufacturer's recommendations.

2.03 MANUFACTURED SUPPORTS

A. Stock Parts

1. Where not specifically indicated, designs that are generally accepted as exemplifying good engineering practice and using stock or production parts shall be utilized wherever possible.

2. Such parts shall be locally available, new, of best commercial quality, and designed and rated for the intended purpose.

B. Manufacturers, or Equal

1. **Basic PSA, Inc.**

2. **Bergen-Paterson Pipe Supports Group**

3. **Grinnell**

4. **Power Piping Company**

5. **TOLCO (Eaton B-Line)**

2.04 COATING

A. Unless otherwise indicated, fabricated pipe supports other than stainless steel or non-ferrous supports shall be blast-cleaned after fabrication and hot-dip galvanized in accordance with ASTM A 123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel

Products and shall receive protective coatings in accordance with the requirements of Section 09 96 00.10 – High Performance Coatings.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. General

1. Pipe supports, hangers, brackets, anchors, guides, and inserts shall be installed in accordance with the manufacturer's printed instructions and per ANSI/MSS SP-58 Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

2. Embedded concrete inserts for pipe hangers and supports shall be coordinated with the formwork.

B. Appearance

1. Pipe supports and hangers shall be positioned in order to produce an orderly, neat piping system.

2. Hanger rods shall be vertical, without offsets.

3. Hangers shall be adjusted to line up groups of pipes at the proper slope for drainage and venting, as close to ceilings or roofs as possible, and without interference with other Work.

3.02 FIELD FABRICATION

A. Quality Control

1. Field fabricated pipe hangers and supports shall be fabricated and installed by experienced welders and fitters, using the best welding procedures available.

2. Hangers and supports shall be neat in appearance without sharp corners, burrs, or edges.

END OF SECTION

SECTION 40 05 24 – STEEL PROCESS PIPE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide steel pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping General and 40 05 07 – Pipe Supports apply to the Work of this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 05 01	Piping General
40 05 07	Pipe Supports

C. Reference References

American Society of Mechanical Engineers (ASME)	
ASME B16.3	Malleable-Iron Threaded Fittings
ASME B16.4	Cast Iron Threaded Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
ASME B16.9	Factory-Made Wrought Steel Butt Welding Fittings
ASME B16.11	Forged Fittings, Socket - Welding and Threaded
ASME16.12	Cast Iron Threaded Drainage Fittings
ASME B16.21	Nonmetallic Flat Gaskets for Pipe Flanges
ASTM International (ASTM)	
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A105	Standard Specification for Carbon Steel Forgings for Piping Applications
ASTM A106	Seamless Carbon Steel Pipe for High Temperature Service
American Water Works Association (AWWA)	
AWWA C606	Joints, Grooved and Shouldered Type

PART 2 -- PRODUCTS

2.01 PIPE MATERIAL

A. Water, Air, Fuel Gas, Oil, Steam, and Waste Service: Unless otherwise indicated, galvanized and black steel pipe shall conform to ASTM A53 Type E or S- Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless or ASTM A106 - Seamless Carbon Steel Pipe for High Temperature Service, Grade B, and shall be Schedule 40 or 80, as indicated in the Piping Schedule. Galvanized steel pipe shall not be cement mortar lined unless so indicated.

2.02 PIPE JOINTS

A. Black steel pipe for general service shall have threaded ends with NPT threads, welded joints, or flanged joints. Threaded joints shall be made up with Teflon tape and welded joints may have butt-weld fittings, socket-weld fittings, or flanges. Where indicated, black steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

B. Black steel pipe for chlorine or sulfur dioxide pressure service shall be socket-welded except where required to match mating fittings of vacuum regulator-check units, gas filters, valves, diaphragm units, gauges, and switches.

C. Galvanized steel pipe shall have threaded ends with NPT threads made up with Teflon tape. Where indicated, galvanized steel pipe shall have grooved ends for shouldered couplings or plain ends for sleeve-type couplings.

D. Where pressure conditions permit, black and galvanized steel pipe may have push-on joints for compression type fittings. For high pressure service these joints shall be harnessed.

2.03 FITTINGS

A. Common Use: The following fittings shall be provided for galvanized or black steel pipe, as indicated in the Piping Schedule:

1. Threaded malleable iron fittings conforming to ASME B16.3 - Malleable-Iron Threaded Fittings, Classes 150 and 300.

2. Threaded cast iron fittings conforming to ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.

3. Forged steel socket welded fittings conforming to ASME B16.11 - Forged Fittings, Socket - Welding and Threaded.

4. Butt welding fittings conforming to ASME B16.9 - Factory-Made Wrought Steel Butt Welding Fittings, Schedule 40 or 80, as indicated.

5. Threaded cast iron drainage fittings conforming to ASME16.12 - Cast Iron Threaded Drainage Fittings.

6. Flanged steel fittings conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.

7. Grooved ductile iron fittings with grooving dimensions conforming to AWWA C606 - Joints, Grooved and Shouldered Type.

8. Compression-type steel fittings with armored Buna S gaskets for plain end pipe.

B. Special Applications

1. Fittings for chlorine and sulfur dioxide under pressure shall be Class 3000. forged steel socket welded fittings conforming to ASTM A105, Grade 2 - Forgings, Carbon Steel, for Piping Components, and Class 3000. forged steel fittings conforming to ASME B16.11, as indicated in the Piping Schedule.

2. Flanges for chlorine and sulfur dioxide pressure service shall conform to ASTM A105, ASME B16.5, Class 300, with 1/16-inch raised face, with 1/16-inch-high temperature, compressed, self-centering ring type gaskets to ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.

3. Unions shall be 4 bolt tongue and groove, ammonia type, suitable for chlorine and sulfur dioxide service, with female threads and lead gaskets. Unions shall be rated for 500 lb. CWP service pressure, reducing-type, straight-type or blind-type, as required for the installation. Blind unions shall be provided as cleanouts where indicated, and straight unions shall be provided adjacent to each threaded valve or piece of equipment. Unions shall be as manufactured by **Henry Valve Machine Company (Vogt Valves Inc.),** or equal. High tensile alloy steel corrosion-resistant bolts and nuts shall be used with each set of flanged unions.

PART 3 -- EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 40 05 01 - Piping General.

END OF SECTION

SECTION 40 05 31.13 – POLYVINYL CHLORIDE PROCESS PIPE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide polyvinyl chloride (PVC) pressure pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping General and Section 40 05 07 – Pipe Supports apply to the Work of this Section.

C. This Section includes PVC pressure pipe with solvent-welded, flanged, or threaded joints. PVC pipe with bell and spigot joints is included in Section 33 95 50 – PVC Pressure Pipe, Elastomer Joints.

1.02 SUBMITTALS

A. Provide submittals of PVC piping, fittings, and solvent cement per Section 01 33 00 – Submittal Procedures

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
33 95 50	PVC Pressure Pipe, Elastomer Joints.
40 05 01	Piping General
40 05 02	Piping Identification
40 05 07	Pipe Supports

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM D1785	Poly (Vinyl Chloride) (PVC) Plastic Pipe
ASTM D2467	Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings
ASTM D2564	Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM F1498	Taper Pipe Threads 60 Degrees for Thermoplastic Pipe and Fittings
American Water Works Association (AWWA)	
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)

AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution

PART 2 -- PRODUCTS

2.01 PIPE MATERIAL

A. PVC pipe shall be made from new rigid unplasticized polyvinyl chloride and shall be normal impact Type 1, Grade 1, class 12454, Schedule 80, listed as compliant with NSF Standard 61, unless otherwise indicated, in accordance with ASTM D1785 –Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

B. PVC piping for reclaimed water service shall have an integral purple color (Pantone Purple, 552C).

2.02 PIPE JOINTS

A. Pipe joints shall be solvent-welded type with solvent cement and primer as recommended by the pipe manufacturer for the fluid in the pipe.

1. Contractor shall provide a suitable solvent cement for the sodium hypochlorite and sodium hydroxide in areas of pipe containing chemicals as shown on the Drawings.

B. Threaded joints that are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape. Pipe threads shall conform to ASTM F1498 - Taper Pipe Threads 60 Degrees for Thermoplastic Pipe and Fittings and shall be full and cleanly cut with sharp dies or molded.

C. Flanged joints shall be made with solvent-welded PVC flanges, drilled to ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated.

2.03 FITTINGS

A. Solvent Welded and Threaded Fittings: Solvent-welded and threaded fittings shall be Schedule 80 PVC fittings in accordance with ASTM D2467 - Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.

B. Flanged Fittings: Flanged fittings shall be Schedule 80 fabricated PVC fittings with Class 150 flanges in accordance with ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2.04 SOLVENT CEMENT

A. Solvent cement shall be in accordance with ASTM D2564 and certified by the manufacturer for the service of the pipe.

B. Potable Water Applications: Solvent cement listed by NSF for potable water applications.

C. Contractor to use solvent cement and primer which is compatible with the associated PVC pipe and fittings, and with the specific chemical service of the PVC pipe.

D. Manufacturer: **IPS® Corporation**, or equal.

2.05 COATING

A. Exposed PVC piping shall be coated/painted in accordance with Section 09 96 00.10 – High Performance Coatings.

PART 3 -- EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 40 05 01 - Piping General.

END OF SECTION

SECTION 40 05 31.23 – CHLORINATED POLYVINYL CHLORIDE PROCESS PIPE

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide chlorinated polyvinyl chloride (CPVC) pressure pipe and appurtenances, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping General, and Section 40 05 07 - Pipe Supports apply to the Work of this Section.

1.02 SUBMITTALS

A. Provide submittals of CPVC piping, fittings, and solvent cement per Section 01 33 00 – Submittal Procedures.

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
40 05 01	Piping General
40 05 07	Pipe Supports

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM D1784	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (PVC) Compounds
ASTM F437	Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings
ASTM F439	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings
ASTM F441	Chlorinated Poly (Vinyl Chloride) (CPVC), Plastic Pipe
ASTM F493	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings

PART 2 -- PRODUCTS

2.01 PIPE MATERIAL

A. CPVC pipe shall be in accordance with ASTM F441 - Chlorinated Poly (Vinyl Chloride) (CPVC), Plastic Pipe, Schedules 40, and 80, from all new compounds, meeting the

requirements of Class 23447 per ASTM D1784 - Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (PVC) Compounds. CPVC pipe shall be Schedule 80 pipe unless otherwise indicated. CPVC material shall be listed as compliant with NSF Standard 61 when used in contact with potable water or chemicals used for the treatment of potable water.

2.02 PIPE JOINTS

A. Pipe joints shall be solvent-welded with solvent cement in accordance with ASTM F493 - Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings, and with primer compatible with the solvent cement.

1. Contractor shall provide suitable solvent cement for sodium hypochlorite and sodium hydroxide in areas of piping containing those chemicals as shown on the Drawings.

B. Threaded joints which are necessary to match up to threaded valves or fittings shall be made up with appropriate thread sealant, either paste or tape.

C. Flanged joints shall be made with solvent-welded CPVC flanges, drilled to ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150, unless otherwise indicated.

2.03 FITTINGS

A. Solvent-Welded Fittings: Solvent-welded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F439 - Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80. For chemical service applications, solvent cement shall be formulated and labeled for use on that chemical.

B. Threaded Fittings: Threaded fittings shall be Schedule 80 CPVC fittings in accordance with ASTM F437 - Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.

C. Flanged Fittings: Flanged fittings shall be Schedule 80 fabricated CPVC fittings with Class 150 flanges to ASME B16.5 - Pipe Flanges and Flanged Fittings, Class 150.

2.04 SOLVENT CEMENT

A. Solvent cement shall be in accordance with ASTM F493.

B. Potable Water Applications: Solvent cement and primer listed by NSF for potable water applications.

C. Chemical service applications: Primer: **IPS® Weld-On P-70™**, Cement: **IPS® Weld-On 724™**, and certified by the manufacturer for the chemical services.

D. Manufacturer: **IPS® Corporation**, or equal.

PART 3 -- EXECUTION

3.01 GENERAL

A. Installation, inspection, and field testing of the pipes shall in accordance with the requirements of Section 40 05 01 - Piping General.

END OF SECTION

SECTION 40 05 31.83 - PVC TUBING

PART 1 -- GENERAL

1.1 THE REQUIREMENT

A. The CONTRACTOR shall provide polyvinyl chloride (PVC) tubing, complete and in place, in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 - Piping, General, apply to the WORK of this Section.

C. This Section includes flexible PVC tubing for chemical lines.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 SUBMITTALS

A. Comply with Section 01 33 00 – Submittal Procedures.

B. Product Data.

C. Manufacturer’s published material description and installation instructions.

1.4 ABBREVIATIONS

A. ID: Inside diameter of tubing.

B. PVC: Polyvinyl chloride.

PART 2 -- PRODUCTS

2.1 TUBING MATERIAL

A. PVC tubing shall be a clear, flexible tubing, constructed of NSF-61 certified PVC with braided polyester textile yarn reinforcement.

B. Tubing ID shall be of the dimensions indicated on the drawings and tubing shall be suitable for a minimum working pressure of 100 psi at 70 °F.

C. Tubing shall be compatible with the chemicals it will carry.

2.2 CONNECTIONS

A. Where tubing is installed within a pipe, as in a double containment system, tubing shall be one piece and no connections shall be allowed. Where connections are indicated on the drawings, all fittings, connections, and solvents shall be compatible with all chemicals being conveyed in containment pipes.

B. Interconnection between hose/tubing and PVC or CPVC pipe shall be made using properly sized barbed fittings and 316 stainless steel clamps, to be determined in the field.

2.3 MANUFACTURERS, OR EQUAL

A. **Kentak**

B. **New Age Industries**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: PVC tubing shall be installed in a neat and workmanlike manner.

END OF SECTION

SECTION 40 05 51 – COMMON REQUIREMENTS FOR PROCESS VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. Provide valves, actuators, and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The requirements of Section 40 05 01 – Piping General and 46 10 00 – Equipment General Provisions, apply to the Work of this Section.

C. The provisions of this Section shall apply to all valves and valve actuators except where otherwise indicated.

D. Valves and actuators in particular locations may require a combination of units, sensors, limit switches, and controls, as indicated.

E. Support

1. Where a valve is to be supported by means other than the piping to which it is attached, obtain from the valve manufacturer a design for its support and foundation that satisfies the criteria in Section 46 10 00 – Equipment General Provisions.

F. Unit Responsibility

1. The Contractor shall assign a single manufacturer to be responsible for the supply, coordination of design, assembly, testing, and furnishing of each type of valve; however, the Contractor shall be responsible to the Owner for compliance with the requirements of each valve Section.

2. Valves shown within the confines of the membrane filtration system as shown on the P&IDs may be supplied by a different manufacturer and submitted separately. All valves shall meet the requirements of this section, and individual valve specifications.

G. Single Manufacturer

1. Where 2 or more valves of the same type and size are required, the valves shall be furnished by the same manufacturer, with the exception of valves as part of the membrane filtration system as shown on the Drawings.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Metal Fabrications
09 96 00.10	High-Performance Coatings
40 05 01	Piping General

40 05 02	Piping Identification
40 05 57	Valve and Gate Actuators
46 10 00	Equipment General Provisions

C. Reference Standards

American National Standards Institute (ANSI)

American Water Works Association (AWWA)

ASTM International (ASTM)

ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 216	Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
ASTM A 351	Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
ASTM A 395	Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures
ASTM A 515	Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service
ASTM A 536	Standard Specification for Ductile Iron Castings
ASTM B 62	Standard Specification for Composition Bronze or Ounce Metal Castings
ASTM B 584	Standard Specification for Copper Alloy Sand Castings for General Applications

Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)

MSS SP-25	Standard Marking Systems for Valves, Fittings, Flanges, and Unions

NSF International (NSF)

NSF/ANSI 61	Drinking Water System Components – Health Effects

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Furnish the following information on Shop Drawings:

1. Valve name, size, Cv factor, pressure rating, identification number (if any), and specification section number.

2. Complete information on the valve actuator, hydraulic power units (HPU), pneumatic air supply system including size, manufacturer, model number, limit switches, and mounting.

3. Cavitation limits for control valves.

4. Assembly drawings showing part nomenclature, materials, dimensions, weights, and relationships of valve handles, hand wheels, position indicators, limit switches, integral control systems, needle valves, and control systems.

5. Data in accordance with Division 26 and Section 40 05 57 – Valve and Gate Actuators, for electric motor-actuated valves.

6. Complete wiring diagrams and control system schematics; and,

7. A valve-labeling schedule, listing the valves to be furnished with stainless steel tags, indicating in each case the valve location and the proposed wording for the label.

8. If indicated on the drawings, submit the valve support design, including drawings and calculations sealed by an engineer, with the Shop Drawings.

C. Furnish a technical manual containing the required information for each valve, as indicated.

D. Furnish a spare parts list, containing the required information for each valve assembly, as indicated.

E. Factory Test Data

1. Where indicated, submit signed, dated, and certified factory test data for each valve requiring certification, before shipping the valve.

2. Furnish a certification of quality and test results for factory-applied coatings.

F. Field Test Data

1. Submit signed, dated, and certified field test data for each valve.

1.4 WARRANTY

A. Comply with the warranty requirements outlined in Division 0.

B. Submit warranty documentation.

PART 2 -- PRODUCTS

2.1 PRODUCTS

A. General

1. Provide valves and gates of new and current manufacture.

2. Provide valves 6-inch and larger with actuators with position indicators.

3. Unless otherwise indicated, provide valve actuators in accordance with Section 40 05 57 – Valve and Gate Actuators.

B. Protective Coating

1. Coat the exterior surfaces of valves and the wet interior surfaces of ferrous valves of sizes 2-inch and larger in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

2. The valve manufacturer shall certify in writing that the required coating has been applied and tested in the manufacturing plant prior to shipment, in accordance with the indicated requirements.

3. Do not coat the machined flange faces of valves except where such flanges are not adjoining a mating flange as shown in the Contract Documents. Apply rust inhibitor coating on machined surfaces of the flange prior to shipment.

C. Valve Labeling

1. Except when such requirement is waived by the Engineer in writing, provide a label on shut-off valves and control valves except for hose bibbs.

2. Furnish a label composed of 1/16-inch plastic or stainless steel, a minimum of 2 inches by 4 inches in size, as indicated in Section 40 05 02 – Piping Identification, and permanently attached to the valve or on the wall adjacent to the valve as directed by the Engineer.

D. Valve Testing

1. As a minimum, unless otherwise indicated or recommended by the reference standards, test valves 3 inches in diameter and smaller in accordance with the manufacturer's standard procedure.

2. Factory-test valves 4 inches in diameter and larger as follows:

a. Hydrostatic Testing

1) Subject valve bodies to an internal hydrostatic pressure equivalent to twice the water-rated pressure of the valve.

2) Metallic valves rating pressures shall be based at 100 degrees F.

3) Plastic valves rating pressures shall be based at 73 degrees F, or at a higher temperature according to material type.

4) During the hydrostatic test, there shall be no visible leakage through the valve body, end joints, or shaft seals, nor shall parts of the valve be permanently deformed.

5) Allow test duration of at least 10 minutes, in order to allow visual examination for leakage.

b. Seat Testing

1) Test the valves for leaks in the closed position, with the pressure differential across the seat equal to the water rated pressure of the valve.

2) Provide test duration of at least 10 minutes, in order to allow visual examination for leakage.

3) The leakage rate shall be the more stringent of the following:

a) As recommended by the reference standard for that type of valve; or

b) Leakage past the closed valve not to exceed one fluid ounce per hour per inch diameter for metal seated valves and drop-tight for resilient seated valves.

c. Performance Testing

1) Shop-operate the valves from the fully-closed to the fully-open position and reverse under no-flow conditions in order to demonstrate that the valve assembly operates properly.

E. Certification

1. Prior to shipment of valves with sizes larger than 12-inches in diameter, submit certified, notarized copies of the hydrostatic factory tests, showing compliance with the applicable standards of AWWA, ANSI, or ASTM.

F. Valve Markings

1. Permanently mark valve bodies in accordance with MSS SP-25 - Standard Marking Systems for Valves, Fittings, Flanges, and Unions.

2.2 MATERIALS

A. General

1. Provide materials suitable for the intended application.

2. Materials in contact with potable water shall comply with NSF/ANSI 61.

3. Ensure that materials not indicated are of high-grade standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

4. Unless otherwise indicated, provide valve and actuator bodies conforming to the following requirements:

a. Cast Iron: Close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

b. Ductile Iron: ASTM A 536 - Ductile Iron Castings, or to ASTM A 395 - Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.

c. Steel: ASTM A 216 - Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service, or to ASTM A 515 - Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service.

d. Bronze: ASTM B 62 - Composition Bronze or Ounce Metal Castings, and valve stems not subject to dezincification shall conform to ASTM B 584 - Copper Alloy Sand Castings for General Applications. Bronze materials in contact with potable water service shall be free of lead content meeting the Lead Reduction Act.

e. Stainless Steel: Stainless steel valve and operator bodies and trim shall conform to ASTM A 351 - Steel Castings, Austenitic, for High-Temperature Service, Grade CF8M, or shall be Type 316 stainless steel.

f. PVC: Polyvinyl chloride materials for valve body, flanges, and cover shall conform to Cell Classification 12454.

g. CPVC: Chlorinated Poly Vinyl Chloride materials for valve body, flanges, and cover shall conform to Cell Classification 23447.

h. NSF/ANSI 61: Materials shall be listed for use in contact with potable water.

i. Elastomeric materials used for seat, seals, flange gaskets and O-rings shall be compatible with temperature, pressures and fluid or gas service as indicted on the pipe schedule.

1) Provide elastomeric materials compatible with chlorinated water service up to 5 ppm chlorine.

2.3 VALVE CONSTRUCTION

A. Bodies

1. Provide valve bodies that are cast, molded (in the case of plastic valves), forged, or welded, of the materials indicated, and with smooth interior passages.

2. Provide wall thicknesses uniform and in agreement with the applicable standards for each type of valve, without casting defects, pinholes, and other defects that could weaken the body.

3. Perform welds on welded bodies by certified welders and ground welds smooth.

4. Provide valve ends as indicated and rated for the maximum temperature and pressure to which the valve will be subjected.

B. Valve End Connections

1. Unless otherwise indicated, valves 2-1/2 inches in diameter and smaller may be provided with threaded end connections.

2. Provide valves 3 inches in diameter and larger with flanged end connections, unless indicated otherwise on the Drawings.

3. Flanges, bolts and gaskets shall be as specified in Section 40 05 01 - Piping General.

C. Bonnets

1. Connect valve bonnets to the body by clamping, screwing, or flanging.

2. Provide bonnets of the same material, temperature, and pressure rating as the body.

3. Make provisions for the stem seal with the necessary glands, packing nuts, and yokes.

D. Stems

1. Provide valve stems of the materials indicated, or, if not indicated, of the best commercially-available material for the specific service, with adjustable stem packing, O-rings, chevron V-type packing, or other suitable seal. Bronze materials in contact with potable water shall be NSF 61 approved and free of lead. Elastomeric materials shall be compatible with fluid service.

2. Where dezincification is not a problem, bronze conforming to ASTM B 584 may be used, except that the zinc content shall not exceed 16 percent.

E. Stem Guides

1. Provide stem guides spaced with an L/R ratio not to exceed 200:1. Submit calculations for L/R ratios and guide spacing to the Engineer for review.

2. Stem guides shall have slotted holes and shall be adjustable in two directions.

3. Construct submerged stem guides from Type 316 stainless steel.

F. Internal Parts

1. Provide internal parts and valve trim as indicated for each individual valve.

2. Where not indicated, construct valve trim from Type 316 stainless steel or other material best-suited for the intended service.

G. Nuts and Bolts

1. Unless otherwise indicated, provide nuts and bolts on valve flanges and supports in accordance with the requirements of Section 05 50 00 – Metal Fabrications and Section 40 05 01 – Piping General.

2.4 TORQUE TUBES

A. Submerged or buried valves with a remote gearbox and actuator shall be supplied with a torque tube to transfer torque from the actuator to the valve. Torque tubes shall be directly connected to the valve and the floor stand and gear actuator. Each torque tube and floor stand shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, torque tubes shall be made of schedule 40, steel pipe with epoxy coating suitable for the fluid service. Each submerged valve, torque tube, floor stand and actuator shall be pre-assembled and “matched marked” in the manufacturer’s shop to ensure proper fit when assembled in field.

2.5 EXTENSION SHAFT STEM

A. Valves mounted in dry areas with gearbox attached to the valve and with remote actuator shall be supplied with an extension shaft stem with universal joint attached to the gear and actuator. All components shall be sized to operate under the maximum service conditions for the valve. Unless otherwise indicated, shaft stem and universal joints shall be made of carbon steel with epoxy coating suitable for the fluid service. Each valve, shaft stem, floor stand and actuator shall be pre-assembled and “matched marked” in the manufacturer’s shop to ensure proper fit when assembled in field.

2.6 VALVE ACTUATORS

A. Valve actuators shall be as indicated and as specified in Section 40 05 57 – Valve and Gate Actuators.

2.7 VALVE ACCESSORIES

A. Provide valves complete with the accessories required to provide a functional system.

2.8 SPARE PARTS

A. Furnish the required spare parts, suitably packaged and labeled with the valve name, location, and identification number.

B. Furnish the name, address, and telephone number of the nearest distributor for the spare parts of each valve.

C. Spare parts are intended for use by the Owner, after expiration of the correction of defects period.

2.9 MANUFACTURERS

A. Valve manufacturers shall have a successful record of not less than 5 years in the manufacture of the indicated valves.

B. Refer to individual valve specifications for manufacturers.

PART 3 -- EXECUTION

3.1 VALVE INSTALLATION AND TRIAL OPERATION

A. General

1. Install valves, actuating units, stem extensions, valve boxes, and accessories in accordance with the manufacturer's written instructions and as indicated.

2. Adequately brace gates in order to prevent warpage and bending under the intended use.

3. Firmly support valves in order to avoid undue stresses on the pipe.

B. Access

1. Install valves in a manner to provide easy access for actuation, removal, and maintenance, and to avoid interference between valve actuators and structural members, handrails, and other equipment.

C. Valve Accessories

1. Where combinations of valves, sensors, switches, and controls are indicated, properly assemble, and install such items such that systems are compatible and operating properly.

2. Clearly note the relationship between interrelated items on Shop Drawing submittals.

D. Trial Operation

1. After installation, schedule trial operation witnessed by the Engineer and the Owner representative.

2. All valves shall be cleaned thoroughly of all foreign materials and final adjustments made. The valves shall then be operated through one complete cycle from a fully closed position to a fully open position and back to a fully closed position to verify that the assembly is functional.

3. For control valves that operate in multiple operating scenarios, the Contractor shall simulate all operational scenarios including the hydraulic power units, pilot control system or pneumatic air supply system to demonstrate compliance to the specifications.

4. A field leakage test meeting the maximum allowable specified requirement shall be conducted.

5. Test certificate shall be signed by the valve manufacturer and the Contractor and shall be submitted to the Engineer.

END OF SECTION

SECTION 40 05 57 – VALVE AND GATE ACTUATORS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide valve and gate actuators and appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section apply to valves and gates except where otherwise indicated in the Contract Documents.

C. Unit Responsibility

1. The valve or gate manufacturer shall be responsible for the coordination of design, assembly, testing, and installation of actuators on the valves and gates; however, the Contractor shall be responsible to the Owner for compliance of the valves, gates, and actuators with the Contract Documents.

D. Where 2 or more valve or gate actuators of the same type or size are required, the actuators shall be produced by the same manufacturer.

E. The requirements of Division 26 apply to the Work of this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
05 50 00	Metal Fabrications
09 96 00.10	High-Performance Coatings
26 00 00	Electrical Work, General
40 90 10	Control Strategies
40 05 51	Common Requirements for Process Valves

C. Reference Standards

American National Standards Institute (ANSI)	
ANSI/ASME B 31.1	Power Piping
American Society of Mechanical Engineers (ASME)	
ASME BPVC SEC VIII	Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
American Water Works Association (AWWA)	
AWWA C 500	Metal-Seated Gate Valves for Water Supply Service

AWWA C504	Rubber-Seated Butterfly Valves
AWWA C541	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
AWWA C 542	Electric Motor Actuators for Valves and Slide Gates
ASTM International (ASTM)	
ASTM A 105	Forging, Carbon Steel, for Piping Components
International Electrotechnical Commission (IEC)	
IEC 801.5	Surge Immunity Test
IEC 1000-4-5	Electromagnetic Compatibility Testing and Measurement Techniques – Surge Immunity Test
IEC 1000-4-8	Power Frequency Magnetic Field Immunity Test
National Fire Protection Association (NFPA)	
NPFA 70	National Electrical Code

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures and Section 40 05 51 – Common Requirements of Process Valves.

B. Submit Shop Drawing information for actuators with the valve and gate submittals as a complete package.

C. Submit calculations showing dynamic seating and unseating torques versus the output torque of the actuator.

1.4 WARRANTY

A. Comply with the warranty requirements outlined in Division 0 and reference specifications.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Unless otherwise indicated, provide shut-off and throttling valves and externally actuated valves and gates with manual or power actuators.

B. Provide actuators complete and operable with mounting hardware, motors, gears, controls, wiring, solenoids, hand wheels, levers, chains, and extensions, as applicable.

C. Provide actuators with torque ratings equal to or greater than required for valve seating and dynamic torques, whichever is greater, and capable of holding the valve in any intermediate position between fully-open and fully-closed without creeping or fluttering.

D. Actuator torque ratings for butterfly valves shall be determined in accordance with AWWA C504 - Rubber-Seated Butterfly Valves.

E. Identify wires of motor-driven actuators by unique numbers.

F. Manufacturers

1. Where indicated, certain valves and gates may be provided with actuators manufactured by the valve or gate manufacturer.

2. Where actuators are furnished by different manufacturers, coordinate the selection to result in the fewest number of manufacturers possible.

G. Materials

1. Provide actuators of current models, of the best commercial quality materials, and liberally sized for the required torque.

2. Provide materials suitable for the environment in which the valve or gate is to be installed.

H. Actuator Mounting and Position Indicators

1. Securely mount actuators by means of brackets or hardware specially designed and sized for this purpose and of ample strength.

2. Cast the word "OPEN" on each valve or actuator, with an arrow indicating the direction to open in the counter-clockwise direction.

3. Equip gear and power actuators with position indicators.

4. Where possible, locate manual actuators between 48 and 60 inches above the floor or the permanent working platform.

I. Standards

1. Unless otherwise indicated and where applicable, provide actuators in accordance with AWWA C 542 - Electric Motor Actuators for Valves and Slide Gates.

J. Functionality

1. Coordinate electric, pneumatic, and hydraulic actuators with the power requirements of Division 26 – Electrical, and instrumentation equipment as indicated in Section 40 91 00 – Process Control Instrumentation Systems .

K. Provide fasteners in accordance with the requirements of Section 05 50 00 – Metal Fabrications.

L. Provide coatings in accordance with the requirements of Section 09 96 00.10 – High-Performance Coatings.

2.2 MANUAL ACTUATORS

A. General

1. Unless otherwise indicated, provide valves and gates with manual actuators.

2. Provide valves in sizes up to and including 4 inches with direct-acting lever or hand wheel actuators of the manufacturer's best standard design.

3. Provide valves and gates larger than 4-inch with gear-assisted manual actuators, with an operating pull of maximum 60 pounds on the rim of the hand wheel.

4. Valves 6-inch to 24-inch diameter may be provided with traveling-nut actuators, worm gear actuators, spur or bevel gear actuators, as appropriate for each valve.

B. Buried Valves

1. Unless otherwise indicated, provide buried valves with extension stems to grade, with square nuts or floor stands, position indicators, and cast-iron or steel pipe extensions with valve boxes, covers, and operating keys.

2. Where indicated, provide buried valves in cast-iron, concrete, or similar valve boxes with covers of ample size in order to allow operation of the valve actuators.

3. Permanently label the valve box covers as required by the local Utility Company or the Engineer.

4. Provide wrench-nuts in compliance with AWWA C 500 - Metal-Seated Gate Valves for Water Supply Service.

C. Chain Actuator

1. Provide manually-activated valves with the stem located more than 7 feet above the floor or operating level with chain drives consisting of sprocket-rim chain wheels, chain guides, and operating chains supplied by the valve manufacturer.

2. Construct the wheel and guide from ductile iron, cast iron, or steel.

3. Chains

a. Fabricate the chain from hot-dip galvanized steel or stainless steel, and extend to 5 feet, 6 inches above the operating floor level.

b. Provide an extra strong valve stem on chain-actuated valves in order to allow for the extra weight and chain pull.

c. Provide hooks for chain storage where chains interfere with pedestrian traffic or equipment.

D. Floor Boxes

1. Provide hot-dipped galvanized cast iron or steel floor boxes and covers to fit the slab thickness, for operating nuts in or below concrete slabs.

2. For operating nuts in the concrete slab, provide a bronze-bushed cover.

E. Tee Wrenches

1. Furnish buried valves with floor boxes with 2 operating keys or one key per 10 valves, whichever is greater.

2. Size the tee wrenches such that the tee handle will be 2 to 4 feet above ground, and to fit the operating nuts.

F. Manual Worm Gear Actuator

1. Provide an actuator consisting of a single- or double-reduction gear unit contained in a weatherproof cast iron or steel body with cover, and a minimum 12-inch diameter handwheel.

2. Provide the actuator to be capable of a 90-degree rotation and equip the actuator with travel stops capable of limiting the valve opening and closing.

3. Provide the actuator with spur or helical gears and worm gearing.

4. Provide a self-locking gear ratio in order to prevent "back-driving."

5. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

6. Construct the worm gear shaft and the hand wheel shaft from 17-4 PH or similar stainless steel.

7. Accurately cut gearing with hobbing machines.

8. Use ball or roller bearings throughout.

9. Provide the output shaft end with a spline in order to allow adjustable alignment.

10. Actuator output gear changes shall be mechanically possible by simply changing the exposed or helical gearset ratio without further disassembly of the actuator.

11. Design gearing for a 100 percent overload.

12. The entire gear assembly shall be sealed weatherproof.

G. Design and rate buried gear actuators for buried service, provide with a stainless-steel input shaft, and double-seal on shaft and top cap.

H. Traveling-Nut Actuator

1. Provide the actuator with a traveling-nut and screw (Scotch yoke), contained in a weatherproof cast iron or steel housing with a spur gear and a minimum 12-inch diameter hand wheel.

2. The screw shall run in 2 end bearings and provide a self-locking actuator in order to maintain the valve position under any flow condition.

3. Construct the screw and gear from hardened alloy steel or stainless steel, and the construct the nut and bushings from alloy bronze.

4. The bearings and gear shall be grease-lubricated by means of nipples.

5. Design gearing for a 100 percent overload.

2.3 ELECTRIC MOTOR ACTUATORS

A. General

1. Equipment Requirements

    a. Where electric motor actuators are indicated, attach an electric motor-actuated valve control unit to the actuating mechanism housing by means of a flanged motor adapter piece.

2. Gearing

    a. Provide the motor actuator with the motor, reduction gearing, reversing starter, torque switches, and limit switches in a weather-proof NEMA 4 assembly.

    b. Provide a single- or double-reduction unit, consisting of spur or helical gears and worm gearing.

    c. Construct the spur or helical gears of hardened alloy steel, and the worm gear of alloy bronze.

    d. Accurately cut gearing with hobbing machines.

    e. Power gearing shall be grease- or oil-lubricated in a sealed housing.

    f. Use ball or roller bearings throughout.

    g. Actuator output speed changes shall be mechanically possible by simply removing the motor and changing the exposed or helical gearset ratio without further disassembly of the actuator.

3. Starting Device

    a. Except for modulating valves, design the unit such that a hammer blow is imparted to the stem nut when opening a closed valve or closing an open valve.

    b. The device shall allow free movement at the stem nut before imparting the hammer blow.

    c. The actuator motor shall attain full speed before the stem load is encountered.

4. Switches

    a. Electronic-Type Switches

        1) Limit switches or valve position shall be the absolute position type.

        2) The open and closed positions shall be not be lost upon loss of power.

3) The encoder shall measure valve position continuously, including both motor and hand wheel operation, with or without use of battery.

4) Provide an electronic torque sensor.

5) Provide an adjustable torque limit, from 40 to 100 percent of rating in one-percent increments.

6) The motor shall be de-energized if the torque limit is exceeded.

7) Provide a boost function in order to prevent torque-trip during initial valve unseating, and a “jammed valve” protection feature with automatic retry sequence in order to de-energize the motor if no movement occurs.

8) Provide valve actuators with electronic type switches as manufactured by **Limitorque, Rotork** or **Auma Actuators, Inc**.

b. The actuator shall be wired in accordance with the schematic diagram.

c. Connect wiring for external connections to marked terminals.

d. Provide one 1-inch and one 1-1/4-inch conduit connection in the enclosing case.

e. Mount a calibration tag near each switch, correlating the dial setting to the unit output torque.

f. Switches shall not be subject to breakage or slippages due to over-travel.

g. Do not use traveling-nuts, cams, or microswitch tripping mechanisms.

h. Provide limit switch contacts equivalent to the heavy-duty, open contact type, with rotary wiping action.

5. Handwheel Operation

a. Provide a permanently attached handwheel for emergency manual operation.

b. The handwheel shall not rotate during electrical operation.

c. The maximum torque required on the handwheel under the most adverse conditions shall not exceed 60 lb-ft, and the maximum force required on the rim of the handwheel shall not exceed 60 lb.

d. Cast or permanently affix an arrow and either the word "OPEN" or "CLOSE" on the handwheel in order to indicate the appropriate direction to turn the handwheel.

e. Provide a clutch lever to put the actuator into handwheel operation.

f. Provide chain activator handwheels for valves with electric motor actuators having stems more than 7 feet above the floor.

g. Provide the clutch lever with a cable secured to the chain in order to allow disengagement for manual operation.

6. Motor

a. Provide a motor of the totally enclosed, non-ventilated, high-starting torque, low-starting current type, for full-voltage starting.

b. The motor shall be suitable for operation with voltages as indicated on the valve schedule.

c. The observed temperature rise by thermometer shall not exceed 55 degrees C above an ambient temperature of 40 degrees C, when operating continuously for 15 minutes under full-rated load.

d. With a line voltage ranging between 10 percent above to 10 percent below the rated voltage, the motor shall develop full-rated torque continuously for 15 minutes without causing the thermal contact protective devices imbedded in the motor windings to trip or the starter overloads to drop out.

e. Provide bearings of the ball type and provide thrust bearings where necessary.

f. Provide the bearings with suitable seals in order to confine the lubricant and to prevent the entrance of dirt and dust.

g. Provide watertight motor conduit connections.

h. Motor construction shall incorporate the use of stator and rotor as independent components from the valve operation such that the failure of either item shall not require actuator disassembly or gearing replacement.

i. Provide two Class B thermal contacts or solid-state thermistors embedded within the motor windings in order to protect against over-temperature damage.

j. Provide the motor with a space heater unless the entire actuator is of a hermetically sealed, non-breathing design with a separately sealed terminal compartment which prevents moisture intrusion.

k. Provide each electric motor actuator with a lockable local disconnect switch or circuit breaker in order to isolate power from the motor and controller during maintenance activities. Disconnect switches can be close-coupled or remote mounted to be accessible to maintenance personnel.

7. Open/Close Operating Speed

a. Unless otherwise indicated, electric actuators shall provide a full-close-to-full-open or full-open-to-full-close operating time range from 30 to 55 seconds.

b. Provide an open/close speed for motor/power-actuated valves as indicated in the following table:

Valve Tag No.	Location	Service	Type of Valve	Motor (AC or DC) or Hydraulic	Actuator Type (Modulating/ Open-Close)	Open / Close Speed, seconds
MOV-0107	Raw Water Control Vault	RAW WATER	Plug	AC Reversing	Modulating	30s

8. Elevated Valves

    a. For valves with electric motor actuators where the valve centerline is located at a height greater than 6 feet above the floor, provide a remote actuator control station at a location no higher than 4 feet above the floor.

    b. Provide conduit and wiring between the actuator controls and the valve actuator for these applications.

    c. Wall-mount the actuator controls beneath the valve at a location approved by the Engineer.

B. Electric Motor Actuators (AC Modulating Control Type)

1. General

    a. Where indicated, modulating electric motor actuators shall be of the AC-modulating type, provided complete with a local control station with power disconnect switch or circuit breaker, LOCAL/REMOTE switch, non-latching OPEN/CLOSE pushbuttons, and OPEN/CLOSE status lights. The local controls shall be integral to the actuator unless otherwise required to the remotely located.

2. Actuator Appurtenances

    a. Provide the actuator for each valve with a padlock able disconnect switch; OPEN and CLOSED status lights; OPEN, CLOSE, and LOCKOUT/STOP pushbuttons; a LOCAL/REMOTE selector switch; and other indicated devices.

3. Control Module

    a. Provide a control module of the electronic solid-state AC type, with control outputs for positioning the valve via 4 to 20 ma input signals.

4. Starter

    a. The actuator shall control a solid-state reversing starter designed for minimum susceptibility to power line surges and spikes.

    b. The solid-state starter and control module shall be rated for continuous modulating applications.

    c. The power supply shall be as shown on the equipment list in the drawings.

d. Provide a lockable disconnect switch with each actuator, either close-coupled or remote depending on installation location.

5. Construction

a. The control unit shall be microprocessor-based and shall contain an analog/digital converter, separate input-output switches, non-volatile random-access memory for storage of calibration parameters, and push-button calibration elements for field setup.

b. The controller shall contain as a standard feature a loss-of-command signal protection selectable to lock in last or lock in pre-set valve position and a valve position output signal in 4 to 20 mA

c. As an alternative to the construction requirement, provide a motor capable of modulating at a rate of 600 starts per hour at the 50-percent to 85-percent travel range of the valve.

d. The system shall allow the control of the open, close, or percent open function when the LOCAL/REMOTE switch is in the REMOTE position.

e. Provide each actuator with a frequency shut-down system, which when pre-programmed shall function as directed upon receipt of an ESD signal.

6. Electric Motor Actuators (AC Modulating Control Type) Manufacturer, or Equal

a. EIM

b. Limitorque

c. Rotork

d. Auma Actuators, Inc.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Field Adjustments

1. The adjustment of actuator controls and limit switches in the field for the required function shall be performed by field representatives of the manufacturers of valves or gates with pneumatic, hydraulic, or electric actuators.

3.2 INSTALLATION

A. Install valve and gate actuators and accessories in accordance with the requirements of Section 40 05 51 – Common Requirements for Process Valves.

B. Locate the actuators to be readily accessible for operation and maintenance without obstructing walkways.

C. Do not mount actuators where shock or vibrations will impair their operation, and do not attach the support systems to handrails, process piping, or mechanical equipment.

D. Cleaning

1. After installation, thoroughly inspect and clean the piping to remove machining burrs and foreign materials, including mill scale, dirt, rust, oil, grease, weld spatter, and cutting chips.

2. Perform cleaning in strict accordance with the manufacturer's written instructions.

E. Field-Testing

1. After installation, hydraulically test the fluid power system and piping to 150% of the maximum working pressure.

END OF SECTION

SECTION 40 05 62 – PLUG VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide plug valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

C. The requirements of Section 40 05 57 – Valve and Gate Actuators apply to this Section.

D. Plug valves shall have undergone a proof-of-design test to demonstrate that the valve components operate at the service flow, pressure, temperature, and fluid conditions, free from binding, excessive noise, and premature failures. Proof-of-design test results shall be available to the Engineer on request. The proof-of-design test shall be conducted in accordance with the applicable provisions of AWWA C517- Resilient-Seated Cast-Iron Eccentric Plug Valves.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

09 96 00.10	High-Performance Coatings
40 05 51	Common Requirements for Process Valves
40 05 57	Valve and Gate Actuators

C. Reference Standards

American Water Works Association (AWWA)	
AWWA C517	Resilient-Seated Cast-Iron Eccentric Plug Valves
ASTM International (ASTM)	
ASTM A 126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A 216	Steel Castings, Carbon, Suitable for Fusion Welding for High-Temperature Service
ASTM A 536	Ductile Iron Castings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.1 ECCENTRIC PLUG VALVES (1/2-INCH TO 72-INCHES)

A. Construction: Eccentric plug valves shall be of the non-lubricated, eccentric plug design with cast iron bodies conforming to ASTM A 126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings, with ANSI 125 lb. flanged ends for valves 3-inches and larger, and screwed or flanged ends for smaller sizes. The plugs and shafts shall be of cast iron or ductile iron conforming to ASTM A 536 - Ductile Iron Castings, and the plugs shall be lined with a resilient coating, best suited for the specific service. The body shall be lined with a suitable elastomer, where required for a special service, or it shall be epoxy-lined in accordance with Section 09 96 00.10 – High-Performance Coatings. The seats shall be of nickel or stainless steel welded to the body. Top and bottom shaft bearings shall be of permanently lubricated stainless steel or Teflon coated stainless steel. Grit seals of Teflon, Nylatron, or similar suitable material shall be at the top and bottom plug journals.

B. Buried Valves:

1. Valves shall be buried as indicated on the Civil and Process Drawings.

C. Actuators:

1. Valve actuation to be as described in Section 40 05 62.

2. Provide 2-inch square operating nut on top of the buried valve. The nut shall attach to a valve stem as indicated in the Civil standard details in the Drawings.

3. Provide two additional valve stem tees to allow operators to actuate plug valves from above ground level. Tee to be minimum 3-feet length with cross bar to match the actuation force of a handwheel per Section 40 05 57 – Valve and Gate Actuators.

D. Manufacturers, or Equal

1. **DeZurik Corporation**

2. **Clow Valve Company**

3. **Pratt Valve**

4. **Victaulic**

5. **Mueller**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Plug valves shall be installed in strict accordance with the manufacturer's published recommendations and the applicable provisions of Section 40 05 51 – Common Requirements for Process Valves.

B. Eccentric Plug Valves: Unless otherwise directed, the following rules shall be observed for the installation of eccentric plug valves on sewage, sludge, or other liquid systems containing solids, silt, or fine sand:

1. The valves shall be positioned with the stem in the vertical direction.

2. In horizontal pipelines, the plug shall swing upwards when opening, to permit flushing out of solids.

3. The orientation of the valve shall prevent the valve body from filling up with solids when closed; however, where the pressure differential through the valve exceeds 25 psi, the higher pressure for valves without worm gear, electric, or air operators shall be through the valve to force the plug against the seat.

4. Valves which may be closed for extended periods (stand-by, bypass, or drain lines) and valves with reversed flow (higher pressure on downstream side, forcing the plug away from its seat), shall be equipped with worm gear operators for the full range of sizes.

5. For special applications or when in doubt, consult with the manufacturer prior to installation.

END OF SECTION

SECTION 40 05 63 – BALL VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide ball valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

C. The requirements of Section 40 05 57 – Valve and Gate Actuators apply to this Section.

D. The requirements of Section 46 30 00 – Chemical Feeding Equipment, General apply to this Section. Where ball valves are used for chemical service piping as indicated on the pipe schedule in the Drawings, the materials of the ball valve shall be compatible with the chemical(s) in use.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 05 51	Common Requirements for Process Valves
40 05 57	Valve and Gate Actuators
46 30 00	Chemical Feeding Equipment, General

C. Reference Standards

American Petroleum Institute (API)	
API 6D	Specification for Pipeline Valves (resilient seated)
API 607	Fire Test for Soft-Seated Valves (resilient seated)
American National Standards Institute (ANSI)	
ANSI B 16.5	Pipe Flanges and Flanged Fittings
American Water Works Association (AWWA)	
AWWA C507	Standard for Ball Valves 6-inches through 48-inches (resilient seated)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

1.4 SINGLE MANUFACTURER

A. Similar ball valves shall be supplied by a single manufacturer as much as possible.

PART 2 -- PRODUCTS

2.1 BALL VALVES (6-INCHES AND LARGER)

A. Construction: Unless otherwise indicated, ball valves shall be in accordance with AWWA C507 - Standard for Ball Valves 6-inches through 48-inches (resilient seated), API 6D - Specification for Pipeline Valves (resilient seated), or API 607 - Fire Test for Soft-Seated Valves (resilient seated), with cast iron, ductile iron, or cast steel bodies, flanged ends, suitable for velocities up to 35 fps, temperatures up to 125 degrees F, and design pressures to 150 psi. The balls shall be of cast iron, ductile iron, or cast steel, shaft- or trunnion-mounted, with tight shut-off, single or double seat, and full bore. The valves shall be rubber-, soft- (nylon, teflon, polymer, or similar), or metal-seated, with stainless steel, forged steel, or monel shafts or trunnions, and not less than one thrust bearing.

B. Actuators: Unless otherwise indicated, ball valves shall have manual actuators with handwheel, position indicator, and 2-inch square operating nut. Operators for buried valves and for power-actuated valves shall be in accordance with provisions of Section 40 05 57 – Valve and Gate Actuators.

C. Manufacturers, or Equal.

1. **Apco/Willamette**

2. **Grove Valve and Regulator Company**

3. **GA Industries**

4. **Neles-Jamesbury, Inc.**

5. **NIBCO, Inc.**

6. **Henry Pratt Company**

2.2 PLASTIC BALL VALVES

A. General: Plastic ball valves for corrosive fluids shall be made of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polypropylene (PP), or polyvinylidene fluoride (PVDF), as recommended by the manufacturer for the specific application. Valves shall have manual actuators in accordance with Section 40 05 57 – Valve and Gate Actuators, unless otherwise indicated.

B. Construction: Plastic ball valves shall have union ends or flanged ends to mate with ANSI B 16.5, class 150 flanges for easy removal. The balls shall have full size ports and teflon seats. Body seals, union O-ring seals, and stem seals shall be in accordance with the corrosion resistance requirements of chemicals used as shown on the pipe schedule in the Drawings. External (without entering into the wetted area) seat packing adjustment is preferred. Metal reinforced stems to prevent accidental breakage are preferred. Ball valves for sodium hypochlorite solution service shall be drilled through the ball or body per valve manufacturer recommendation to relieve off gas and equalize pressure across the valve. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F for PVC and CPVC, with decreasing ratings for higher temperatures and other plastics.

C. Manufacturers, or Equal

1. **ASAHI-America**

2. **George Fischer, Inc.**

3. **NIBCO Inc., (Chemtrol)**

4. **Plast-O-Matic Valves, Inc.**

5. **Spears Mfg. Co.**

6. **Watts Regulator**

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with Section 40 05 51 – Common Requirements for Process Valves. Care shall be taken that valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 05 64 – BUTTERFLY VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide butterfly valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 46 10 00 – Equipment General Provisions apply to this Section.

C. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

D. The requirements of Section 40 05 57 – Valve and Gate Actuators apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

09 96 00.10	High-Performance Coatings
40 05 51	Common Requirements for Process Valves
40 05 57	Valve and Gate Actuators
46 10 00	Equipment General Provisions

C. Reference Standards

American National Standards Institute (ANSI)	
ANSI B 16.1	Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
American Petroleum Institute (API)	
API 598	Valve Inspection and Testing
API 609	Butterfly Valves: Double-flanged, Lug- and Wafer-type, and Butt-welding Ends
American Society of Mechanical Engineers (ASME)	
ASME B31.1	Power Piping
ASME B31.3	Process Piping
American Water Works Association (AWWA)	
AWWA C504	Standard for Rubber-Seated Butterfly Valves
AWWA C541	Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates
ASTM International (ASTM)	
ASTM A 36	Standard Specification for Carbon Structural Steel

ASTM A 216	Steel Castings, Carbon Suitable for Fusion Welding for High-Temperature Service
ASTM A 240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
ASTM A 276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A 351	Steel Castings, Austenitic, for High-Temperature Service
ASTM A 439	Standard Specification for Austenitic Ductile Iron Castings
ASTM A 515	Pressure Vessel Plates, Carbon Steel, for Intermediate-and Higher-Temperature Service
ASTM A 536	Standard Specification for Ductile Iron Casting
ASTM A 564	Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless-Steel Bars and Shapes
ASTM A 743	Castings, Iron-Chromium, Iron-Chromium-Nickel, and Nickel-Base Corrosion - Resistant for General Application
ASTM UNS S31803 SS	Duplex Stainless Steel

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

B. Shop Drawings

1. Complete Shop Drawings of butterfly valves and actuators.

2. Drawings showing valve port diameter complete with dimensions, part numbers, and materials of construction.

3. Dynamic seating and unseating torque for motor actuated valves.

4. Certified statement of proof-of-design tests from the valve manufacturer. Valve manufacturer shall state that the valves proposed for this project will be manufactured with identical basic type of seat design and materials of construction to the prototype evaluated under the proof of design testing.

5. Manufacturer's certification that the valve complies with applicable provisions of AWWA C504 – Rubber-Seated Butterfly Valves.

1.4 QUALITY ASSURANCE

A. Valves shall be subjected to performance, leakage, and hydrostatic tests in accordance with procedures and acceptance criteria established by AWWA C504.

PART 2 -- PRODUCTS

2.1 RUBBER SEATED BUTTERFLY VALVES 25 TO 150 PSI (AWWA)

A. General: Butterfly valves for steady-state water working pressures and steady-state differential pressure up to 150 psi and for freshwater service having a pH range from 6 to 10 and temperature range from 33 to 125 degrees F shall conform to AWWA C504 and be as indicated. Valves subjected to steady state working pressures and steady state differential pressures from 25 to 150 psi in sizes 3-inches through 24-inches shall be rated for Class 150B with actuator sized for Class 150B.

B. Valves shall be of the body type, pressure class, end joint, and actuator indicated.

C. Construction: Unless otherwise indicated, materials of construction shall be in accordance with AWWA C504, suitable for the service. Seats shall be positively clamped or bonded into the disc or body of the valve, but cartridge-type seats that rely on a high coefficient of friction for retention shall not be acceptable. Seat material shall be guaranteed to last for at least 75 percent of the number of cycles in the AWWA C504 proof-of-design test without premature damage.

Description	**Material Standards**
Valve bodies	Gray iron, ASTM A 48, Class 40 or Gray iron, ASTM A 126, Class B, or Ductile iron, ASTM A 536, grade 65-45-12 or 70-50-05 Alloy gray iron, ASTM A 436, Type1 or 2, or ASTM A 439, Type D2, with minimum lead content of 0.003 percent
End flanges	Same material as valve bodies
Valve shafts	Stainless steel ASTM A 240 or A 276, Type 316
Valve discs	Same material as valve bodies.
Rubber seats	New natural or synthetic rubber
Seat mating surfaces	Stainless steel, ASTM A 240 or A 276, Type 316
Clamps and retaining rings	Type 316 retaining rings and cap screws.
Valve bearings	Self lubricating materials per AWWA C504
Shaft seals	Resilient non-metallic materials suitable for service
Painting and coating	Refer to Section 09 96 00.10 – High Performance Coatings

D. Manual Actuators: Unless otherwise indicated, manually-actuated butterfly valves shall be equipped with a handwheel and 2-inch square actuating nut and position indicator. Screw-type (traveling nut) actuators will not be permitted for valves 30-inches in diameter and larger.

E. Electric Actuators: Electric actuators shall meet the requirements of AWWA C542. Electric actuators in open and close service shall be rated to produce output torque of at least 1.5 times the required valve maximum seating or maximum dynamic torque, whichever is greater. For valves in modulating service with dynamic torque exceeding the seating torque, the rated output torque of the actuator shall be twice the dynamic torque required by the valve. Actuator rated torque is defined as pullout torque rated at 10 percent below the rated voltage of the motor. The torque switch shall be field set at no greater than 60 percent and 50 percent of the maximum actuator rated torque for open/close service and modulating service, respectively. After plant startup, the manufacturer shall prepare a certification including a torque curve to demonstrate that the torque requirements have been met.

F. Manufacturers, or Equal

1. **DeZURIK Water Controls, Corporation**
2. **Kennedy Valve**
3. **M & H Valve Company**
4. **Mueller Company**
5. **Henry Pratt Company**
6. **Val-Matic Rodney Hunt Company** (24-inches and larger)

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Exposed butterfly valves shall be installed with a means of removing the complete valve assembly without dismantling the valve or operator. Installation shall be in accordance with Section 40 05 51 – Common Requirements for Process Valves.

END OF SECTION

SECTION 40 05 65.10 – CHECK VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide check valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 05 51	Common Requirements for Process Valves

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B1.20.1	Pipe Threads, General Purpose (inch)
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings
American Water Works Association (AWWA)	
AWWA C508	Swing-Check Valves for Waterworks Service
ASTM International (ASTM)	
ASTM A48	Gray Iron Castings
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM B16	Free-Cutting Brass Rod, Bar, and Shapes for Use in Screw Machines
ASTM B148	Aluminum-Bronze Castings
ASTM B584	Copper Alloy Sand Castings for General Applications
ASTM B763	Copper Alloy Sand Castings for Valve Application

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.1 INTERNAL SPRING-LOADED CHECK VALVES (GLOBE STYLE)

A. General: Internal spring-loaded check valves for water pumps, compressors, gas, air, and steam shall be of the full-flow internal spring-loaded poppet type. The valves shall be designed for a water-working pressure of not less than 150 psi unless otherwise indicated.

B. Body: The bodies of valves 3-inches and larger shall be of cast iron conforming to ASTM A126 with 125 lb flanged ends conforming to ASME B16.1 unless otherwise indicated. Where necessary, there shall be a positive, watertight seal between the removable seat and the valve body. The stem guide shall be integrally cast with the body or screwed into the body.

1. Valves smaller than 3-inches shall have bronze bodies with screwed ends conforming to ASME B1.201, suitable for a minimum working pressure of 200 psi, and a temperature of 250 degrees F, unless otherwise indicated. The type of bronze shall be suitable for the intended service.

C. Disc and Stem: The disc and stem of all valves in sizes 3-inches and larger shall be of bronze conforming to ASTM B584 - Copper Alloy Sand Castings for General Applications, or stainless steel. The stem shall have 2-point bearings. The downstream bearing shall have a bronze or other suitable bushing, to provide a smooth operation.

1. Valves smaller than 3-inches shall have discs and retaining rings of Teflon, nylon, or other suitable material, and stems of bronze, brass, or stainless steel, suitable for the intended service.

D. Stem Guide: The stem guide shall be either firmly fixed in the valve body to prevent it from sliding into the adjacent pipe and damaging the pipe lining, or the valve manufacturer shall provide each valve with one matching flange compatible with the adjacent pipe and its lining to prevent damage to the lining. The compatible flange shall be part of the Shop Drawing submittal.

E. Seat: Valves for general service at temperatures up to 250 degrees F shall have bubble-tight shut-off with resilient seats of Buna-N, Teflon, or other suitable material. Valves for steam service and temperatures over 250 degrees F shall have metal-to-metal seating of bronze or stainless steel, as recommended by the manufacturer for the specific service condition. Resilient seats shall be firmly attached to the seating ring by compression molding or other acceptable method.

F. Spring: Valves in sizes 3-inches and larger shall have Type 316 stainless steel springs, and valves smaller than 3-inches shall have stainless steel or beryllium copper springs, as suitable for the service. The spring tension of the valves shall be designed for the individual pressure condition of each valve.

G. Manufacturers, or Equal

1. **DeZurik/APCO**

2. **VAL-MATIC (Valve and Manufacturing Corporation)**

2.2 PLASTIC BALL CHECK VALVES

A. General: Plastic ball check valves for corrosive fluids, in sizes up to 4-inches, shall be used for vertical up-flow conditions only, unless the valves are provided with spring actions.

B. Construction: The valve bodies and balls shall be of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polyvinylidene fluoride (PVDF), or polypropylene (PP) construction, as best suited for each individual service condition. They shall have unions with socket connections or flanged ends conforming to ASME B16.5 - Pipe Flanges and Flanged Fittings, class 150. Seals shall have Viton O-rings, and valve design shall minimize possibility of the balls sticking or chattering. The valves shall be suitable for a maximum working non-shock pressure of 150 psi at 73 degrees F.

C. Manufacturers, or Equal

1. **ASAHI-AMERICA**

2. **George Fischer, Inc.**

3. **NIBCO Inc. (Chemtrol Division)**

4. **Spears Mfg. Co. (PVC, CPVC, AND PP only)**

2.3 PLASTIC SWING OR WYE-CHECK VALVES

A. General: Plastic swing or wye-check valves for corrosive fluids, in sizes up to 8-inches or as available, may be used for horizontal or vertical up-flow conditions.

B. Construction: The valve bodies and discs or piston shall be of PVC, PP, or PVDF construction as best suited for each individual service condition. They shall have flanged ends conforming to ASME B16.5 Class 150, and flanged top access covers and shall shut positively at no-flow conditions. The seats and seals shall be of EPDM, Teflon, or Viton. The PVC valves shall be rated for a maximum non-shock working pressure of 150 psi at 73 degrees F for sizes 3-inches and smaller. For larger sizes and other materials and temperatures the pressure rating may be lower.

C. Manufacturers, or Equal

1. **ASAHI-AMERICA**

2. **George Fischer, Inc.**

3. **Spears Mfg. Co. (Plastic Swing Check only)**

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Common Requirements for Process Valves.

END OF SECTION

SECTION 40 05 67.36 – PRESSURE REDUCING VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure reducing valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51– Common Requirements for Process Valves, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 05 51	Common Requirements for Process Valves

C. Reference Standards

ASTM International (ASTM)	
ASTM B62	Composition Bronze or Ounce Metal Castings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves, including a cavitation study from the valve manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Function: Pressure reducing valves shall reduce an upstream pressure to a pre-set constant lower pressure, regardless of fluctuations in the upstream pressure.

B. Operation: The valves shall be hydraulically-operated, with diaphragm or piston direct action, pilot-controlled, per paragraph 2.2, and shall be of the globe or angle pattern as indicated. Necessary repairs shall be possible without removing the valves from the pipeline. The smaller direct-acting valves with threaded ends per paragraph 2.3, shall be suitable for water or air service and shall be of the globe pattern.

2.2 THREADED VALVES, SIZES 1/2 TO 2-1/2 INCHES

A. Valve Body: The valve body shall be bronze to ASTM B62 or cast steel, with a minimum pressure rating of 300 psi, and with threaded ends. The valve shall be provided with an integral or an attached strainer with access cap or plug and a flanged or threaded valve cover. The valve shall be actuated by a diaphragm or piston.

B. Valve Trim: The valve stems, springs, body seats, and washers shall be of Series 300 stainless steel. The strainers shall be of stainless steel or monel and the diaphragms shall be of reinforced neoprene. The valve pistons and piston liners shall be bronze to ASTM B62.

C. Operating Conditions: The following conditions are shown on the valve schedule:

1. Maximum inlet pressure (PSI)

2. Minimum inlet pressure (PSI)

3. Maximum outlet pressure (PSI)

4. Maximum flow (gpm)

5. Valve diameter

D. Spare Parts: The following spare parts shall be furnished in accordance with Section 40 05 51 – Common Requirements for Process Valves:

1. One complete set of resilient seals and discs

2. One diaphragm (for diaphragm valves, only)

E. Manufacturers, or equal

1. **Cla-Val Company**

2. **Fisher Controls**

3. **GA Industries**

4. **Watts, ACV**

5. **Wilkins Regulator Div. (Zurn Industries)**

2.3 PLASTIC VALVES, SIZES 1/4- TO 3-INCHES

A. Plastic pressure reducing valves shall be designed for not less than 150 psi water working pressure and shall be suitable for the fluid service. For chemicals and corrosive fluids, solenoid valves shall be PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or teflon materials of construction as recommended by the manufacturer for the specific application.

B. Characteristics: Valves shall open when the outlet pressure drops below a set minimum value and maintain the pressure and open wide as flow requirements dictate. Valves shall be spring- or hydraulically-operated, direct acting, adjustable, diaphragm or piston type as indicated. For chemical applications, the backpressure valves, shall be diaphragm operated and have anti-siphon functions.

C. Operating Conditions: The following conditions are shown on the valve schedule:

1. Maximum inlet pressure (PSI)

2. Minimum inlet pressure (PSI)

3. Maximum outlet pressure (PSI)

4. Maximum flow (gpm)

5. Valve diameter

D. Manufacturers, or equal

1. **Plast-O-Matic Valves, Inc.**

2. **George Fisher**

3. **Hayward Flow Control**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Common Requirements for Process Valves.

3.2 SERVICES OF MANUFACTURERS

A. Inspection, Startup, and Field Adjustment: The service representative of the valve manufacturer shall be present at the Site for up to 1/2 day, to assist the Contractor in the installation and adjustment of the valve(s).

B. Instruction of Owner's Personnel: The training representative of the valve manufacturer shall be present at the Site for up to 1/2 day to instruct the personnel in the operation, adjustment, and maintenance of the valve(s).

C. For the purpose of this paragraph, a Day is defined as an 8-hour period, excluding travel time.

END OF SECTION

SECTION 40 05 67.39 – PRESSURE-RELIEF VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide pressure relief valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves, apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 05 51	Common Requirements for Process Valves

C. Reference Standards

ASTM International (ASTM)	
ASTM B 62	Composition Bronze or Ounce Metal Castings

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

1.4 SPECIAL WARRANTY REQUIREMENT

A. The valve shall be warranted for a period of 3 years from the date of shipment to be free of defects in materials and workmanship.

PART 2 -- PRODUCTS

2.1 THREADED PRESSURE RELIEF VALVES, SIZES 1/2- THROUGH 2-1/2 INCHES

A. Valve Characteristics: The pressure relief valve shall open when the inlet water pressure exceeds a set maximum level. It shall maintain that pressure and gradually close as the pressure drops below the maximum pressure. The valve shall be a spring and hydraulically-operated, direct-acting, adjustable diaphragm or piston type globe or angle valve as indicated.

B. Valve Body: The valve body shall be bronze with threaded inlet and outlet to standard NPT and with flanged top, suitable for an inlet pressure up to 300 psi. The spring shall be adjustable with an adjusting screw, to regulate the pressure setting.

C. Valve Trim: The valve trim shall be of stainless steel or bronze with stainless steel spring. The rubber seat shall be replaceable.

D. Pressure Setting: The valve shall be set for a relief pressure of 80 psi.

E. Manufacturers, or equal

1. **Cla-Val Company**

2. **Golden-Anderson**

3. **Ross Valve Mfg. Co., Inc.**

2.2 PLASTIC PRESSURE RELIEF VALVES, SIZES 1/2- THROUGH 1-1/2 INCHES

A. Plastic pressure relief valves shall be suitable for the fluid service and shall be designed for a maximum of 150 psi water working pressure. For chemicals and corrosive fluids, pressure relief valves shall be of PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or teflon, as recommended by the manufacturer for the specific application.

B. Characteristics: Pressure relief valves shall open when the inlet pressure exceeds a set maximum level. It shall maintain that pressure and gradually close as the inlet pressure drops below the maximum pressure. Valves shall be spring or hydraulically-operated, direct acting, adjustable diaphragm or piston type globe or angle valve, as indicated.

C. Manufacturers, or equal

1. **Plast-O-Matic Valves, Inc.**

2. **Simtech**

3. **George Fischer**

4. **Hayward Flow Control**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Common Requirements for Process Valves.

3.2 SERVICES OF MANUFACTURER

A. The service representative shall be available via email, telephone or video call to answer questions from the Contractor during procurement, installation and testing.

END OF SECTION

SECTION 40 05 74.10 – DIAPHRAGM VALVES

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide diaphragm valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves apply to this Section.

C. The requirements of Section 40 05 57 – Valve and Gate Actuators apply to this Section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 05 51	Common Requirements for Process Valves
40 05 57	Valve and Gate Actuators

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM A126	Gray Iron Castings for Valves, Flanges, and Pipe Fitting
ASTM A395	Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Construction: Diaphragm valves shall be of the weir type, unless otherwise indicated, and be of the material combination best suited for each individual application. They shall be suited for bi-directional throttling service and installation in any position, with bubble-tight shut-off. Valves on outlets and drain nozzles of storage tanks shall have lined metal bodies.

B. Actuators: Unless otherwise indicated, diaphragm valves shall have manual hand-wheel actuators with position indicators and transparent plastic stem covers of clear acrylic, polycarbonate, or similar material. Valve actuators shall be in accordance with Section 40 05 57 – Valve and Gate Actuators. The handwheels shall be of cast-iron, aluminum, or polypropylene.

2.2 PLASTIC BODY DIAPHRAGM VALVES

A. Construction: Unless otherwise indicated, valve bodies shall be of PVC, CPVC, PP, or PVDF construction, as best-suited for each individual service, with union ends, screwed ends, socket-welded ends, spigot ends, or flanged ends to ASME B16.5 - Pipe Flanges and Flanged Fittings, drilled to 150 lb. dimensions, as indicated. The valve bonnets shall be flanged and of PVC, PP, or PVDF construction. The valve compressor stem shall be the same material as the valve body or of a material compatible with the fluid service. The bolts, nuts, and washers shall be of stainless steel and the stem and bonnet seals of Viton or Buna-N O-rings. Valves in sizes 1/2-inch through 4-inch shall have a pressure rating of 150 psi at 73 degrees F, diminishing to not less than 50 psi for larger sizes.

B. Diaphragm: The diaphragms shall be of the best-suitable material for any given service. Unless otherwise recommended by the manufacturer, the diaphragm material shall be chlorosulfonated polyethylene such as Hypalon, Viton, or equal, except that the diaphragms for valves in chlorine solution and chlorine gas lines shall be laminated Teflon/EPDM: diaphragms shall be constructed with suitable lamination to prevent gas migration. Diaphragms shall be of rugged, reinforced construction, be oil resistant, and be designed for long life.

C. Manufacturers, or Equal

1. **ASAHI/America**

2. **George Fischer, Inc. (+GF+)**

3. **ITT Dia-Flo**

4. **Mc Canna, Inc.**

5. **Spears Mfg. Co.**

PART 3 -- EXECUTION

3.1 GENERAL

A. Valves shall be installed in accordance with provisions of Section 40 05 51 – Common Requirements for Process Valves. Care shall be taken that all valves in plastic lines are well supported at each end of the valve.

END OF SECTION

SECTION 40 67 00 – CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 -- GENERAL

1.01 THE SUMMARY

A. General: The Contractor, through the use of a qualified and directly contracted System Supplier, shall provide control panels for the Process Control and Instrumentation System (PCIS), complete and operable, in accordance with the Contract Documents.

B. The System Integrator shall be responsible for selecting, sizing, and furnishing the correct type and quantity of panels required to support the PCIS as detailed in the Contract Documents. Referencing the contract identified and applicable panel equipment, the System Integrator shall have design responsibility for:

1. Sizing of panel equipment to meet load requirements
2. Design of code compliant control and power circuits internal to the cabinet
3. Location and mounting of panel interior and exterior instruments and hardware components
4. Installation and labeling of field interface terminal blocks and patch panels
5. Termination, labeling and managed routing of panel internal wiring and signals
6. Panel and panel component grounding
7. Panel component spacing, heating, and cooling requirements
8. Ensuring adherence to applicable UL codes and posted NEMANEMA rating

C. Package system control panels shall be designed, furnished, and factory tested by the package system Vendor.

D. Contractor responsibilities shall include:

1. Field installation of the System Integrator and Vendor furnished panels
2. Termination of communication / network cabling, power conductors and field signal conductors at each System Integrator and Vendor furnished panel
3. Execution of panel field testing activities

1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

01 33 00	Submittal Procedures
01 75 00	Equipment Testing and Plant Startup

26 00 00	Electrical Work, General
40 91 00	Process Control and Instrumentation Systems
40 95 10	PLC Based Control System Hardware
Division 26	Electrical

C. Reference Standards

Underwriters Laboratories (UL)	
UL Standard 508A	Training on Industrial Control Panels
National Electrical Code (NEC)	
NEC Article 409	Short-Circuit Current Rating (SCCR)
National Fire Protection Association (NFPA)	
NFPA 79	Electrical Standard for Industrial Machinery

D. All panels shall conform to the specifications, codes, and standards requirements detailed in Section 40 91 00 - Process Control and Instrumentation Systems, including:

1. UL Standard 508A

2. NEC Article 409, short-circuit current rating (SCCR)

3. NFPA 79

E. The provisions of this Section apply to local control panels provided for equipment systems specified in other sections unless indicated otherwise in those sections.

F. All panels shall prominently bear the certifying UL label and the NEMA/IP rating label after final assembly.

1.03 CONTRACTOR SUBMITTALS

A. The Submittals shall be furnished in accordance with Section 01 33 00 – Submittal Procedures and Section 40 91 00 - Process Control and Instrumentation Systems.

B. The Contractor shall submit a Control Panel Engineering Submittal (CPES) for each control panel furnished. The CPES shall completely define and document the construction, finish, layout, power circuits, signal and safety grounding circuits, fuses, circuit breakers, signal circuits, internally mounted instrumentation and SCADA system components, face plate mounted instrumentation components, internal panel arrangements, and external panel arrangements. All panel drawings shall, as a minimum, be "B" size with all data sheets, and manufacturer specification sheets being "A" size. The submittal shall be in conformance with ISA-S20 - Standard Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves, shall be submitted as a singular complete bound volume or multi-volume package within 120 calendar days after Notice to Proceed, and shall have the following contents:

1. A complete index shall appear in the front of each bound volume. Drawings and data sheets associated with a panel shall be grouped together with the panels being indexed by systems or process areas. Panel tagging and nameplate

nomenclature shall be consistent with the requirements of the contract requirements.

2. Scale construction drawings which define and quantify the type and gauge of steel to be used for panel fabrication, the ASTM grade to be used for structural shapes and straps, panel door locks and hinge mechanisms, type of bolts and bolt locations for section joining and anchoring, details and proposed locations for "UNISTRUT" members, stiffener materials and locations, electrical terminal box and outlet locations, electrical access locations, print pocket locations, writing board locations, and lifting lug material and locations.

3. Scaled physical arrangement drawings drawn to scale which define and quantify the physical groupings comprising control panel sections, auxiliary panels, subpanels, and racks. Cutout locations with nameplate identifications shall be shown.

4. Front panel layouts for all control panels.

5. Schematic/elementary diagrams shall depict all control devices and circuits and their functions.

6. Wiring/connection diagrams shall locate and identify electrical devices, terminals, and interconnecting wiring. These diagrams show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all electrical and control devices.

7. Interconnection diagrams shall locate and identify all external connections between the control panel/control panel devices and associated equipment. These diagrams show interconnecting wiring by lines, designate terminal assignments, and show the physical location of all panel ingress and egress points.

8. Control sequence diagrams to portray the contact positions or connections required to be made for each successive step of the control action. Written descriptions explaining the control sequence diagrams and system operation shall be furnished.

9. Completed ISA S20 data sheets for all instrumentation devices associated with each control panel supplemented with manufacturer specification sheets which verify conformance to the requirements of the Contract Documents

10. A bill of materials which enumerates all devices associated with the control panel.

11. A priced listing of analog spare parts in conformance with Section 40 91 00 - Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. Factory and field tests shall be performed in accordance with Section 01 75 00 - Equipment Testing and Plant Startup, and Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Environmental Suitability and NEMA Rating

1. Indoor and outdoor control panels and instrument enclosures shall be suitable for operation in the ambient conditions associated with the locations designated in the Contract Documents. Heating, cooling, and dehumidifying devices shall be provided in order to maintain instrumentation devices within 20-percent of the minimums and maximums of their rated environmental operating ranges. The Contractor shall provide power wiring for these devices. Enclosures shall be suitably rated for the environment in which it is to be installed. Panel instruments and equipment to be located in hazardous areas shall be suitable for use in the particular hazardous or classified location in which it is to be installed.

2. Control panels shall be designed and sized to adequately dissipate heat generated by equipment mounted in or on the panel.

3. For outdoor areas classified as general purpose, installed panel rating shall be NEMA 4X, 316 stainless steel construction. For indoor areas classified as general purpose (without washdown consideration), installed panel rating shall be NEMA 304 stainless steel construction unless otherwise indicated.

4. For outdoor chemical areas, selected panel material shall be chemically compatible with anticipated off-gassing constituents, UV resistant and securable.

5. Every effort shall be made to avoid installation of equipment within classified areas. However, if required, implementation shall preferentially employ intrinsically safe (IS) equipment and circuits and/or inert gas purge and pressurization systems where possible. If use of IS circuits with supporting purge and pressurization system is impractical, installed continuous hinged panels shall have a NEMA 7/9 rating and constructed of materials impervious to the environment.

2.02 ENCLOSURES

A. Enclosures shall be as manufactured by:

1. **Hoffman**

2. **Rittal**

3. **Saginaw**

B. Materials / Components

1. Panel section faces shall be No. 12 gauge minimum thickness for free standing panels and No. 14 gauge minimum thickness for wall mounted or pedestal mounted panels. Materials shall be selected for strength, chemical compatibility, application, environmental considerations, and specified project requirements.

2. Relay rack high density type panels shall utilize standard relay racks with No. 14 gauge steel frame and supports.

3. Structural shapes and strap steel shall comply with ASTM A 283 - Low and Intermediate Tensile Strength Carbon Steel Plates, Grade C.

    a. Bolting Material: Commercial quality carbon steel bolts, nuts, and washers shall be 1/2-inch diameter with UNC threads. Carriage bolts shall be used for attaching end plates. All other bolts shall be hex end machine bolts. Nuts shall be hot pressed hex, American Standard, heavy. Standard wrought washers shall be used for foundation bolts and attachments to building structures. Other bolted joints shall have SAE standard lock washers.

4. Construction:

    a. Dimensions shown on the contract panel elevation drawings are provided as reference only. Final enclosure dimensions shall be as determined by the Contractor to accommodate all components required plus spare. Elevations and horizontal spacing shall be subject to Engineer's approval.

    b. For Vendor packages, control panel dimensions shall be as per the Vendor's requirements.

C. Fabrication

1. End plates, top plates, and top closure panels (to hang ceiling) shall be provided when required by the material requisition. End plates, top plates, and top closure panels shall be removable with countersunk bolts to match panels. Top closure panels shall be furnished in lengths which match the widths of standard panels, except that one top closure panel may extend across two 4-foot 6-inch wide or five 2-foot-wide standard panels. The vertical joints of these panels shall align with the vertical joints of the standard panels.

2. End closure or rear closure doors shall be provided where required. Such doors shall be flush fitting, gasketed with closed cell neoprene, and be of the hinged lift-off type with lockable door handles. A common key shall be provided for all doors on one panel assembly. Removable access panels shall be provided with dished handle fasteners. Screwdriver 1/4 turn or Dzus type fasteners are not acceptable.

    a. The flanged edges of all panels shall be straight and smooth. Corners and seams shall be welded and ground smoothly.

    b. The face of the panel shall be true and level after flanging.

    c. All panel cutouts and holes may be cut or drilled by any standard method that does not cause deformation. Burs shall be ground smooth.

    d. Adjacent panels shall assemble with faces flush. Gaps or cracks shall not be visible from the front of the assembled instrument board.

    e. Door and body stiffeners shall be provided where required. The stiffeners shall be welded to the inside of enclosures, as required, to prevent panel deformation due to the weight of face mounted instruments.

    f. Panels shall be self-supporting as defined below.

D. Frameworks and Supports

1. The rear of each panel section shall have a steel framework assembled to support conduit, wireways, switches, piping, and instrument accessory items such as relay or terminal enclosures, transducers, pressure switches, valves, and air relays. The main framework shall be constructed of standard structural shapes. Special shapes such as "**Unistrut**" may be used for secondary support. Framework must neither interfere with instrument connections nor interfere with access needed for maintenance or adjustments.

2. Steel framework shall extend 2-feet 4-inches back from the panel face or as indicated in the material requisition. Where indicated, individual adjustable leg support shall be provided at the back of the framework so that the entire panel is self-supporting

3. The interior rear and sides of each enclosure shall have steel mounting channels for supporting mounting panels.

4. Enclosures shall be provided with external mounting feet, as well as door clamps, hasp and staple for padlocking, data pocket, and closed-cell oil-resistant gasket. Removable lifting lugs to facilitate handling shall be provided on large enclosures.

5. Back and Side Panels: Each enclosure shall be provided with a removable back panel. Depending on the size of the enclosure, more than one back panel may be required. Removable side panels shall be provided as required for additional mounting space

E. Preparation of Panel Surface

1. The following requirements apply to the front and rear face of the panel, both sides and the edges of all flanges, and the periphery of all holes or cutouts.

   a. High spots, burs, and rough spots shall be ground smooth.

   b. The surfaces shall be sanded or sandblasted to a smooth, clean, bright finish.

   c. All traces of oil shall be removed with a solvent.

   d. The first coat of primer shall be applied immediately.

F. Panel Finishing

1. Steel control panels shall be thoroughly cleaned, and sand blasted per Society for Protective Coatings SP 6 (Commercial Blast) after which surfaces shall receive a prime coat of **Amercoat 185H** or equal, 3-mile DFT, for a total thickness of the prime plus finish system of 6 mils. The finished color of the outside surfaces shall be selected by the Engineer, unless otherwise indicated. Interior of the control panel, back-panel, and side panels shall have a white finish coat.

2. A Thin coat primer surface shall be applied over the entire panel surface.

3. Wet sand, dry, then quick glaze spot putty on the front of the panel only. Dry, then wet sand again and dry

4. A primer surface shall be applied on the front of the panel only.

5. Wet sand to smooth clear finish, then dry.

6. At least 2 coats of air-dry, satin finish lacquer enamel shall be applied over the entire surface. Color to be approved by Engineer.

7. Contractor shall supply 2 one-pint containers of air drying, matching paint for field touch-up of the panel face.

8. Non-stainless-steel enclosures shall have an ANSI 61 gray polyester urethane powder coating electrostatically applied to inside and outside surfaces. Enclosure interior, and back and side panels shall be white

G. Finishing and Mounting of Instruments

1. The final coats applied to the painted surface of instrument cases, doors, or bezels which are visible from the front of panels shall be manufacturer's standard unless otherwise indicated. Black japan or "crinkle" finishes on instrument cases are not acceptable.

2. The panel vendor shall provide cutouts and shall mount all instrument items indicated to be panel mounted, including any instruments indicated to be furnished by other vendors but installed in the panel.

3. The panel vendor shall also mount behind the panels for other instrument accessory items as required for functionality as indicated.

4. Equipment mounted at the rear of the panel shall be installed to allow for commissioning adjustments, servicing requirements, and cover removal.

5. Spare space shall be kept clear of wiring, etc., to give maximum space for future additions

6. For front mounted hardware, cutouts and holes may be cut or drilled by any standard method that does not cause deformation. Burs shall be ground smooth. Mounting the instruments shall not degrade the NEMA rating of the enclosure.

7. DIN rail mounted equipment shall be used whenever possible.

8. Installed enclosure equipment shall be provided with an interior nameplate to identify tag and function

9. Ventilation, Louvers, Vents, Filters, and Heaters:

   a. Heating, cooling, and dehumidifying devices shall be provided in order to maintain all instrumentation and control devices within the Manufacturer published operating range

   b. In vented enclosures where excessive internal heat or internal moisture is a design consideration, the enclosure shall be equipped with filtered louvers and a thermostat-controlled cooling fan. The perimeters of the louver plate shall be sealed with a gasket. Louver shall be of the same material and finish as the enclosure. The louver shall be sized for effective heat rejection.

   c. For unvented enclosures, cabinets shall be equipped with a thermostat-controlled recirculation fan, positioned to move air across the critical control and communication components.

d. Thermostat controlled heater or heating strips shall be installed to prevent freezing of components and to mitigate condensation within the cabinet. Enclosure heater (120Vac) shall be manufactured by **Hoffman**.

e. Ventilation fan (120Vac) and filter kit shall be manufactured by **Hoffman, Cooltron,** or Engineer approved equal.

f. Enclosure bi-metallic temperature switch shall be accurate to within ±2.0 degrees Fahrenheit and shall be as manufactured by **Hoffman ATEMNC**, or Engineer approved equal.

10. Include additional panel accessories to meet the specifications, such as floor stand and mounting kits, door handle, and lock kits (common key shall be provided for all doors), 3-point latch, and interior protective pocket to hold panel drawings.

a. 3-point latching handles shall be manufactured by **Hoffman, Powerglide** corrosion resistance model.

2.03 UNINTERRUPTIBLE POWER SYSTEMS

A. Each UPS shall consist of a freestanding UPS module and battery modules as required to meet backup run time requirements.

B. UPS's shall be true on-line type. Each UPS shall be sized to match the maximum power requirements of the associated digital equipment, control panel power supplies, and accessories. Under normal operation, the AC power shall be converted to DC. The DC power from the battery charger shall supply an inverter and maintain the battery module at full charge. The AC output from the inverter shall be fed to the associated digital equipment power supply unit and/or other equipment power supplies as appropriate. Upon loss of the AC supply, the inverter shall continue to supply normal power to the device, drawing DC from the batteries.

C. An automatic bypass switch shall be provided on UPS's of greater than 2 kVA capacity. The transfer switch shall be of the solid state, make-before-break type and shall automatically transfer load from the inverter to the AC line in the event of an inverter malfunction. The total transfer time shall be 5 milliseconds or less. The transfer switch shall be provided with a manual override.

D. A manually operated maintenance bypass switch shall be provided for each UPS installation to allow hardware to be powered while the UPS is removed for maintenance. The bypass switch shall be the make-before-break type to ensure continuous power to the associated PLC.

E. Loss of AC power shall be monitored on the line side of the UPS and reported via normally closed (fail safe) unpowered contacts to the associated PLC/RTU.

F. Each UPS shall meet the following requirements:

1. Input voltage shall be 117 VAC, single phase, 60 Hz.

1. Voltage regulation shall be +/-5 percent for line and load changes.

2. The output frequency shall be phase-locked to the input AC line on AC operation and shall be 60 hertz +/-0.5 percent when on battery operation.

3. The batteries shall be of the sealed, lead acid or lead calcium gelled electrolyte type, or VRLA absorbed glass mat (AGM) type. The battery modules shall have a minimum full load backup time of 30 minutes for PLC-based control panels, and 45 minutes for remote telemetry units.

4. A status monitoring and control panel shall be provided and shall include the following:

    a. Status indicating lights for both normal and abnormal conditions.

    b. Individual alarm contacts that shall close upon loss of the AC line, low battery level, or operation of the static transfer switch. Contacts shall be wired to the closest discrete input subsystem. Alternatively, an RS-232 or USB port shall provide UPS status to an operator workstation. All required interface software and hardware shall be provided.

    c. Circuit breaker for the AC input.

5. Sound absorbing enclosure.

6. EMI/RF noise filtering.

7. Surge protection shall be provided on the AC input circuit, which shall have a UL TVSS clamping voltage rating of 400 V with a <5 ns response time.

G. UPS systems shall be Model GXT2 as manufactured by Liebert, equivalent by Powerware, MGE UPS Systems, GE Digital Energy, or equal.

2.04 ELECTRICAL REQUIREMENTS

A. General Requirements

1. The main power supply to the control panel controls shall be 120 Vac, 60 Hz. Where the electrical power supply to the control panel is 240 Vac single phase or 480 Vac 3-phase, the control panel shall be provided with a control panel transformer. Control conductors shall be provided in accordance with the indicated requirements.

2. The control panel shall be the source of power for any field instrumentation loads, including solenoid valves, which are connected to the control panel

3. The main feeder disconnect shall have a door-mounted handle unless otherwise indicated.

4. Each source of foreign voltage shall be isolated by providing disconnecting or pull-apart terminal blocks or a disconnect operable from the control panel front. Each control panel shall be provided with identified terminal strips for the connection of all external foreign voltage. A “CAUTION - Foreign Voltage” nameplate shall be attached to the outside of the enclosure door warning of foreign voltages inside the enclosure. Each conductor associated with foreign voltages shall be yellow

5. The Contractor shall provide wireways, wire, and electrical fittings and components for 120V and 24Vdc circuits to instruments and other electrical devices in the panel for a complete and operable installation.

6. The circuits for 24Vdc shall run in separate wireways from the 120 Vac circuits

7. Conduit, wireways, junction boxes and fittings shall be provided for signal wire, thermocouple, or resistance thermometer lead wire. Conduit or wireway runs shall include those required between temperature sensors and temperature transmitters and between the thermocouple wireway or junction box and instruments.

8. Use of flexible conduit subject to the requirements of Division 26.

9. Conduit fittings shall be **Crouse Hinds cast fittings** or Engineer approved equal.

10. Each terminal connection shall have a plastic plate with a terminal and instrument tag number. Wiring shall be identified with stamped tubular wire end markers.

11. Freestanding panels shall be provided with switched, natural light, 60-watt equivalent LED light kit. Covered light fixture shall be provided for every 4-feet of panel width and shall be mounted inside and at the top of the back-of-panel area.

12. Freestanding panels shall be provided with a 15-amp, 120-volt, service outlet circuit within the back-of-panel area. The breaker protected circuit shall support one 3-wire, heavy-duty, industrial grade, duplex receptacle, installed every 4-feet of panel width (one minimum per panel), spaced evenly along the back-of-panel area. GFCI receptacle shall be manufactured by **Hubbel, Leviton** or Engineer approved equal.

13. Wall mounted or pedestal mounted panels shall be so sized as to adequately dissipate heat generated by equipment mounted in or on the panel.

14. Wall mounted or pedestal mounted panels mounted outside shall be provided with thermostatically controlled heaters that maintain inside temperatures above 40 degrees F.

15. Provide a hand switch controlled, natural light, 60-watt equivalent LED light kit and a breaker protected 120-volt, 15-amp, industrial grade GFCI duplex receptacle within each wall mounted or pedestal mounted panel larger than 4 cubic feet volume.

B. Wiring Methods - General:

1. The signal, control, and power wiring specified herein shall apply only to wiring inside the control panel. Field wiring shall be in accordance with requirements specified in Division 26

2. Wiring methods and materials for all panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise indicated.

3. Wire numbers shall be marked using white numbered wire markers made from plastic-coated cloth, **Brady Type B-500** or Engineer approved equal, or be heat shrink plastic. Wire numbers shall be marked on all conductors at every terminal connection and shall be readily identifiable without twisting the conductor

C. Control Wiring

1. Wire type and sizes: Conductor shall be flexible stranded copper machine tool wire, UL listed Type MTW and shall be rated 600 volts. Wires for instrument signal circuits and alarm input circuits shall be No. 14 AWG.

a. 120 Vac Control Wires: No. 14 AWG machine tool grade type MTW, rated for 90 degrees C at dry locations, shall be manufactured by **Southwire, Okonite,** or Engineer approved equal.

1) Refer to Power Wiring section for insulation color codes

b. 24 Vdc power, status, alarm, and control wires: Minimum of 16 AWG or heavier as required, with TFFN/MTW insulation

1) The following insulation color code designations shall be used:

a) Positive (+) – Blue

b) Common (-) – Blue/White

c) DC Ground – Green

D. Alarm Wiring

1. Panel Supplier shall install and wire alarms including annunciator cabinets, audible signal units, beacons, test and acknowledge switches, and remote logic units as indicated. Interconnecting wiring to panel mounted initiating devices shall also be wired by the panel supplier. The wiring from external initiating devices shall be provided by the Contractor. Where plug and cord sets are provided for component interconnection, the panel vendor shall harness and support the cables in neat and orderly fashion.

2. Discrete outputs from the control panel shall be provided by electrically isolated contacts rated for 5 amps at 120 Vac.

E. Signal Wiring

1. Analog and instrumentation signal wiring inside the panel shall be No. 16 AWG minimum, twisted shielded pair of stranded and tinned copper conductors rated at 600 volts. Insulation shall be color coded PVC/Nylon:

a. Black-white for 2 conductor cable

b. Black-red-white for 3 conductor (triad) cable.

2. Multi-conductor cables where indicated shall consist of multiple No. 16 AWG stranded and tinned copper conductors twisted in pairs, with 90-C, 600V fault insulation. Multi-conductor cables shall be sized to allow for 10 percent spare signal wire.

3. All analog and Instrumentation cables shall be composed of the individual conductors, an aluminum polyester foil shield, a No. 22, or larger AWG stranded tinned copper drain wire, and a PVC outer jacket with a minimum thickness of 0.047-inches.

4. Single pair, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3090A, similar by Southwire**, or Engineer approved equal.

5. Single triad, No. 16 AWG, twisted, shielded cable shall be **Belden Part No. 3091A, similar by Southwire**, or Engineer approved equal.

6. Analog inputs and outputs shall be isolated 4-20 mA, 2-wire signals with power supply.

F. Power Wiring

1. Unless otherwise indicated, instruments, alarm systems, and motor controls shall operate on 120-volt, 60 Hz circuits. Poer conductors shall be flexible, stranded, copper UL approved type wires, and shall be rated at 600 volts.

a. 120 Vac power wires: Main 120 Vac power wiring for distribution in the control panel (line, neutral and ground) shall be a minimum of 12 AWG, or heavier as required by the panel load, with THHN/THWN insulation.

b. Power conductors in branch circuits such as lighting, receptacle, heater, and thermostat, etc. shall be a minimum of 14 AWG also with THHN/THWN insulation.

c. Wiring for 600-volt class power and lighting shall be manufactured by **Southwire**, **Okonite,** or Engineer approved equal.

d. The following insulation color code designation shall be used:

1) Line Power – Black

2) Neutral (grounded circuits) – White

3) Power Ground – Green

4) Ungrounded 120 Vac control circuit conductors (switched power) – Red

5) Wires energized by 120 Vac source external to the control panel shall have yellow insulation

e. At a location near the top of the panel (or bottom), the panel fabricator shall provide terminal box connections for the main power supply entry.

f. Power supply switches for alarm units shall be 3 pole type, arranged to open both power circuits and alarm circuits. Each annunciator unit shall be equipped with a separate switch.

g. Instruments located on the same panel section and serving the same process unit may be connected to a common branch circuit from the power supply. The number of power distribution circuits depends on the circuit load as noted herein. A 15-amp, 2 pole circuit breaker shall be provided in each branch circuit unless specifically indicated otherwise. The circuit load shall not exceed 10 amp. The interrupting rating shall be 10kA or the maximum available fault current at the line terminal, whichever is higher. Different panel sections or different process units must not use common branch circuits. The circuit breakers shall be a DIN rail mounted type with a manual Open-Close toggle switch. Control circuit breakers shall be manufactured by **Square D**, **Allen Bradley**, or **Phoenix Contact**. Amp ratings shall be as required for the application, and trip shall allow for inrush characteristics. Nominally, unless specifically indicated otherwise:

1) 20-amp main circuit breaker for the 120 Vac control panel power supply and power distribution. Line side terminals shall be covered by a barrier within the panel.

2) 5-amp circuit breaker for the duplex 15-amp, 120 Vac GCFI receptacle used for service and maintenance.

3) 15-amp circuit breaker for the heater, thermostat, and ventilation/recirculation fan.

h. Each potentiometer type instrument, electronic transducer, controller, or analyzer shall have an individual disconnect switch. Disconnect switches shall have metal or plastic tags indicating instrument tag numbers. Individual plug and cord set power supply connections may be used without switches when indicated in the material specification

G. Grounding

1. Provide a ¼-inch by one (1)-inch copper grounding bus bar with multiple connecting terminals. The grounding bus shall be complete with a solderless connector for one #4 AWG bare stranded copper cable and with tapped holes to accommodate ground connections from various devices in the enclosure. Provide ground connections for different gauge wires with shield connection clamps as manufactured by **Phoenix Contact**, or equal. Provide separate ground buses for power and instrumentation signals. The copper cable shall be provided by the Contractor and connected to a system ground loop.

2. Provide grounding strap between the enclosure and the enclosure doors.

3. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND” or the letter “G,” or the color green.

4. Signal Grounding (24 Vdc): Terminate each drain wire of a shielded signal cable to a unique grounding terminal block or common ground bus at the end of the cables.

5. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.

6. Design so that the removal of a device does not interrupt the continuity of the equipment grounding circuit.

7. Size ground wires in accordance with NEC and UL Standards, unless otherwise noted.

8. Connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment grounding circuit.

H. Terminal Blocks

1. Terminal blocks (fused with blown fuse indicator and feed-through type as required) shall be as manufactured by:

a. Weidmuller SAK Series KDKS

b. Phoenix Contact UK5 Series

c. Allen-Bradley Series 1492

2. The control panel shall be provided with sufficient terminal blocks for the connection of external field conductors, signals, and power and for use inside the panel for power distribution and for future expansion. In order to facilitate easy and safe loop maintenance, each analog input loop shall have a fused disconnect with test plugs built into its field terminal block.

3. Terminal blocks shall be positioned so that the internal and external wiring does not cross and with unobstructed access to the terminals and their conductors.

4. Spare Terminal Blocks for Signals: The panel supplier shall provide sufficient spare terminal blocks to connect additional signals for future use (implemented and future spares). Implemented spare signals shall be wired to terminal blocks. The percentage of these terminals shall be in accordance with the growth requirements specified in Section 40 95 10 – PLC-Based Control System Hardware. For future signals (i.e., the source of inputs or final control elements are not yet known or available in the field), the panel supplier shall provide 25-percent spare terminals in the panel for each type of actual I/O in the PLC. The number of terminals shall take into account the types of I/O for which spares are provided.

5. Spare Terminal Blocks for Power and Other Applications: In addition to the spare terminals for signals, the panel supplier shall provide spare terminals for 3 additional power distribution and grounding applications circuits.

6. Terminal blocks for all wiring shall be modular terminals, DIN rail mounted type (35 mm rail) rated for 30 amperes at 600 Vac and have a minimum width of 8-mm suitable for the specified stranded wire gauge. Terminals shall be the solderless box lug type with pressure plates in actual contact with the wire to minimize wire breakage. Each terminal shall have a light-colored strip for marking the terminal number or circuit designation. Terminal identification shall correspond with markings on the drawings and shall be permanent, machine printed identifiers. Double high terminal blocks are not acceptable.

7. External connections to and from enclosures shall terminate on terminal blocks, except approved communication and data cables, which shall terminate in patch panels as specified. Circuit isolating switches and fuse terminals shall include non-conducting pullers which can be removed by finger alone, without tools. Additionally, the panel shall be provided with identified terminal strips for the connection of external/field conductors.

8. Wire duct shall be flame retardant plastic wiring duct, slotted with dust cover. Wire duct shall be manufactured by **Panduit**.

I. Circuit Breakers, Fuses and Disconnects

1. Circuit breakers, fuses and disconnects shall be installed in the control panel to protect against fault current from the 120 Vac and 24 Vdc branch circuits and the instruments and the electrical components that these circuits power. Circuit breakers shall be installed as disconnects of external power feeds for control circuits from outside the enclosure and branch circuits within the enclosure

2. Each circuit breaker and fuse shall be identified by a service nametag.

3. The fuses shall be mounted in a DIN mounted fuse holder terminal block and shall have a blown fuse indicator light. The holders shall have an LED indicator light and shall be **Ferraz Shawmut, Littelfuse, or Bussmann.**

    a. Provide a durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings

    b. Provide fuses that are rated for the voltage and available for short circuit current at which they are applied.

    c. Provide UL listed Class RK1, dual-element, time delay fuses with the amp ratings as required for the application.

    d. Fuse holders shall be of the modular type, DIN rail mountable, and of a touch safe design with all terminals protected against accidental touch. The fuse holder shall incorporate the blown fuse indicator and shall have a nameplate that identifies each fuse. Approved manufacturers include **Weidmuller, Phoenix Contact, or Allen Bradley**.

    e. A fuse, sized as required, shall be provided for the protection of each 24 Vdc branch (including spares) and equipment that is powered by the 24 Vdc power supply. Each analog and discrete input loop shall also be protected by a fuse. A fuse shall be provided to each instrument regardless if it is equipped with an integral replaceable fuse

J. Control Panel 24Vdc Power Supplies

1. Din-rail mountable, redundancy capable power supplies shall be as manufactured by:

    a. Sola

    b. PULS

    c. Phoenix Contact

2. Control panels shall be provided with redundant power supplies which shall be configured in a fault-tolerant manner to mitigate interruption of service. The power supply shall convert 120 Vac to 24 Vdc

3. The panel supplier shall size the power supplies to meet the control panel load plus the field distribution power load supported by the panel. Field distributed power shall include any 24 Vdc two-wire or 4-wire field device, and any PLC controlled solenoid valves. One power supply shall be capable of supporting the full load with an excess rated capacity of 40 percent.

4. Power supply shall be UL508C listed to allow full rated output without de-rating.

5. The failure of a power supply or redundancy module shall generate a dry relay contact output that can be wired as a discrete input to the local PLC.

6. Power supplies shall be DIN rail mountable and of a touch safe design

K. Panel Surge Protection Devices

1. Surge protection devices (SPD) shall be provided for process control loops, field instruments, and field networks for protection against induced current surge and transient surge sources (e.g., lightning, power switching, static discharge, etc.). The SPD shall divert the resulting surges safely to earth and limit voltages to acceptable levels. Panel SPDs shall be as manufactured by:

    a. Emerson EDCO

    b. Phoenix Contact

    c. MTL / Eaton

    d. Islatrol

2. Each end of a loop shall be protected by an SPD - at the control panel side and at the field side instrument or device – as indicated on the P&IDs or the project instrument schedule

3. For hazardous areas, the SPD shall be certified to meet the hazardous area classification required for the environment in which it is to be installed.

4. Technical Data and Design:

    a. The SPD shall be of the fast-acting type, capable of limiting destructive high voltage transients, and accurately controlling voltage. It shall be maintenance-free and shall self-reset once the over voltage event has ceased.

    b. The SPD shall be of a multi-stage hybrid circuit design, incorporating gas-filled discharge tubes (for high surge current diversion) with Zener diodes for fast operation. It shall include the following features:

        1) Minimum withstand of 10kA at 8/20µs total surge current impulse per wire for all 24Vdc discrete and analog control panels interfaces.

        2) Minimum withstand of at least 1.4kA lightning impulse current at 10/350µs total surge current impulse per wire for all 24Vdc discrete and analog control panels interfaces.

        3) Housing shall be modular, 7mm maximum width, and of the DIN rail mount type for all 24 Vdc analog and discrete control panel interfaces. Field SPD shall have ½ NPT threaded connection and shall be housed in a NEMA 4X, UV resistant cabinet.

        4) Operating Ambient Temperature Range: -40ºF to +176ºF

        5) 120Vac discrete circuits shall be protected by 7mm maximum width DIN rail mount, metal oxide varistor (MOV) SPDs for control panel interfaces. Provide visual indication of MOV status on the input and output circuits.

        6) Field instrument SPDs shall be of the threaded conduit entry type with 20kA maximum surge current per wire. 7mm maximum width DIN rail mount units may also be used for 120Vac field instruments as specified.

        7) Range of voltage ratings to suit all process I/O applications.

8) SPD shall include screw type, cable-clamping terminal block to support wiring connections. The connections shall be gas-tight, and the terminal blocks are fabricated of non-ferrous, non-corrosive materials.

L. Nameplates shall be provided on each panel as indicated on the Drawings.

1. Provide in accordance with Section 26 00 00 – Electrical Work, General on all internal and external instruments and devices.

2. Provide a nameplate with the following markings that are plainly visible after installation:

a. Panel Manufacturer's name, trademark, or other descriptive markings by which the organizations responsible for the panel can be identified.

b. Supply voltage, phase, frequency, and full load current.

c. Short-circuit rating of the panel based on one of the following:

1) Short-circuit current rating of a listed and labeled assembly.

2) Short-circuit current rating established utilizing an approved method

3. For all panels, a nameplate shall be mounted on the enclosure door exterior and shall be engraved with the panel tag and description as shown on the contract drawings. (Nameplate material and sizing shall be as detailed in the Division 26 specifications)

M. Status Monitoring

1. PLC and remote IO cabinet components shall support status/alarm monitoring connection to the local PLC / RIO for display at the control system HMI. Component monitoring shall include:

a. Panel interior high temperature alarm switch

b. Panel intrusion switch (one for each door)

c. 24Vdc primary and secondary power supply status monitoring (as detailed in specification 17100-2.1-J).

d. Controller webpage monitoring (as applicable)

e. Air-conditioning unit fault status (as applicable)

N. Dimensions shown on the contract panel elevation drawings are provided as reference only. Final enclosure dimensions shall be as determined by the Contractor to accommodate all components required plus spare.

2.05 PANEL COMPONENTS

A. Panel-mounted devices and panel internal electrical components shall be furnished in accordance with Division 26 specifications. Panel-mounted devices shall be mounted a minimum of 42-inches above finished floor elevation.

B. General Purpose Relays

1. General purpose relays in the control panel(s) shall be compact plug-in type with contacts rated 10 amperes at 120Vac or 24Vdc. Quantity and form of contacts shall be as required by the application.

2. In general, relays have a minimum of two form-C contacts (DPDT), except when used as an interposing relay for PLC DO modules. Interposing relays shall have one form-C contact (SPDT). Each relay shall be provided with an LED to indicate an energized state.

3. The relay socket and mounting shall be a standard DIN rail mount with pullover wire spring (”horseshoe clip”).

4. For all types of 120 Vac relays, provide surge protection across the coil of each relay

5. For all types of 24 Vdc relays, provide a free-wheeling diode across the coil of each relay.

6. Relays shall be **IDEC compact relays type RHXB-UL with SHXB-05 sockets** (where X indicates the number of form C contacts), or Engineer approved equal.

C. Interposing Relays

1. Additional interposing relays shall be provided when the number or type of contacts required to exceed the contact capacity and/or rating of the specified relays and timers. Additional relays shall be provided when higher contact rating is required in order to interface with starter circuits or other equipment. Furnished interposing relays shall be as per the general-purpose relays specified above.

D. Time Delay Relays - Electronic Type

1. Time delay relays shall be plug-in electronic type with on-delay or off-delay actuation as required. Output contacts shall be DPDT, rated for 10-amperes at 240Vac minimum. Each unit shall include an adjustable time delay with a time range scale. Operating temperature range of the units shall be -20 to +120 degrees F. Each device shall be rated for 10,000,000 mechanical operations and 500,000 electrical operations.

2. Time delay relays shall be **IDEC RTE** series or **Allen Bradley type 700-HR series**.

E. Indicating Pilot Lights

1. Indicating lights shall be 30mm, ultra-bright LED, push-to-test type. Lights shall be of heavy-duty, oil-tight, corrosion resistant, weather-proof construction suitable for outdoor installations. Each light shall have a screwed-on prismatic lens approximately 1-inch in diameter. Miniature style devices are not acceptable.

2. Unless specifically noted otherwise, lens colors shall be assigned as follows:

   a. Red for Start / Run / Opened / On / Failure

   b. Green for Stop / Closed / Off

c. White for Status Normal or Powered condition

d. Amber for Alarm Active

3. Provide hazardous location type pilot devices for classified locations

4. Indicating lights shall be **Schneider Harmony 9001K**, or equal. Each pilot light shall have a factory-engraved legend plate, as shown on the Contract Documents.

F. Selector and Pushbutton Switches:

1. Selector switches and pushbuttons shall be rated 10A at 600V; shall be of heavy-duty, oil-tight, weather-proof construction; and shall include the number of required contacts as shown on the contract or Engineer approved wiring schematics.

2. Miniature style devices are not acceptable.

3. Push buttons shall be 30mm type. Lever-type switches shall be furnished as indicated on the P&ID panel elevation drawings

4. Switches shall be **Schneider Harmony 30mm 9001K**, or equal. Each switch shall have a factory-engraved legend plate as shown on the Contract Documents. Furnished switches shall be self-grounding.

G. Signal Splitter

1. Signal splitters shall be capable of generating two identical 4-20mA isolated outputs from a single 4-20mA input. Each input and output channel shall operate independently and shall employ galvanic isolation to prevent interaction, formation of ground loops, and reduce noise. The units shall automatically compensate for load resistance variations from 0 to 1000 ohms. Current output shall be limited to 27mA.

2. Signal splitters shall be as manufactured by **Acromag Model 633T**, or equal

H. Signal Converter / Isolator

1. The current-to-current converter/isolators shall accept a 4 - 20 mA input signal and provide a linear current output signal proportional to the input signal. Unit shall be operated from 120 V power and shall be by **Acromag, Phoenix Contact, or Moore Industries.**

I. Current Transmitter

1. The current transmitter shall be a 4-20ma loop powered device rated from 0-10 amps to 0-600amps. Transmitters for motors 50hp and smaller shall be solid core; transmitters for larger sized motors shall be split core. For DC currents, the transmitter shall utilize a Hall Effect sensor with signal conditioner to measure the potential difference of the detected magnetic field. For AC currents, the transmitter shall utilize an inductive sensor with signal conditioner to measure the current produced by the expanding and collapsing magnetic field. The transmitter shall output a 4-20mA signal proportional to the sensor current measuring range.

2. The transmitter shall be **NK Technologies AT1 series,** or equal.

J. Digital Indicators

1. Digital process indicators shall be self-contained instruments that display process signals directly in engineering units. The unit shall be suitable for panel mounting and shall utilize a 3-1/2 digit LED display of no less than 0.5-inch height. The input signal to the digital process indicator shall be 4-20 mA DC or 1-5 Vdc as indicated. The input sample rate of the unit shall be a minimum of 2 per second. The unit shall have an auto-zeroing feature and shall have provisions for field adjustable scaling and offset. The indicator's setting shall be lockable to avoid accidentally change by unauthorized personnel. Accuracy shall be plus and minus 1 least significant digit. Input power to the digital indicator shall be 120 Vac, 60 Hz.

2. Digital process indicators, with NEMA 4X housing where specified, shall be as manufactured by **Precision Digital**, **Red Lion** or equal

K. Loop Controllers

1. Type: Proportional plus-reset plus derivative process controllers shall be microprocessor based on single loop controllers.

2. Features: Units shall have front panel bar graphs and digital indicators with scales in engineering units as indicated. Fully adjustable high and low process alarm setpoints shall be provided as indicated. Alarm outputs shall be indicated on the front panel of the device. All accessories required for adjustment of control parameters shall be provided.

3. Functions: Process controllers shall include manual-automatic control selection, fully adjustable proportional plus-automatic reset plus-derivative mode(s), bumpless transfer switching, setpoint control and indication, output high and low limiters, and controlled variable and output signal indicating scales. Controllers accept 4-20 mA input signals and provide a similar resultant output signal. In the event of power loss with a controller in either automatic or manual mode, all controller settings shall return to the previous value after power is restored. Proportional band setting shall be fully adjustable from 3 percent to 500 percent. Controllers shall include manual increase and decrease pushbuttons. Reset rate shall be fully adjustable within 0-6 repeats per minute. Controllers shall include anti-reset wind-up feature, and a reset disable feature. Derivative time shall be fully adjustable from 0.05 to 8 minutes. Controllers shall have the implemented capability for disabling the derivative function. Designated controllers shall include a remote setpoint feature, including a remote/local selector switch. Remote setpoint input signal shall be 4-20 milliamperes.

4. Accuracy: Vertical process and setpoint bar graph indicators shall have an accuracy of plus and minus 0.5 percent of span.

5. Size: Enclosures shall be nominally 3-inch by 6-inch suitable for separate or multiple panel mounting.

6. Operating Environment: The units shall be suitable for operation in indoor environments with ambient temperatures between 40 and 120 degrees Fahrenheit and over a range of 10 to 90 percent relative humidity.

7. Power: Controllers shall operate on 120Vac, 60 Hz. Power supplies, if required, shall be provided.

8. Manufacturers, or equal:

    a. Yokogawa YS1500

    b. Red Lion DLC

    c. Or Engineer approved equal.

L. Component Nameplates

1. Nameplates shall be provided for instruments, function titles for each group of instruments, and other components mounted on the front or the inside of the control panel. A nameplate shall be provided for each instrument and device. The nameplates shall be descriptive to define the function and system of such device in accordance with the Contract Documents or the approved shop drawings. Adhesives shall be acceptable for attaching nameplates, however stainless-steel nameplates shall be fastened with screws. Nameplates shall be fabricated from white-face, black-center, laminated engraving plastic for devices within the panel and stainless steel for instruments.

PART 3 -- EXECUTION

3.01 PREPARATION

A. Preparation for Shipment and Shipping

1. Control panels shall be created for shipment using heavy frameworks and skids as required and cushioned to protect the finish and the instruments during shipment. Shipments shall be by air-ride vehicle. Suitable cushioning material shall be used to protect interior hardware that could be damaged due to mechanical shock.

2. Depending on panel size, each separate panel unit shall be provided with removable lifting lugs to facilitate handling.

3. Control panels shall be installed in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

3.02 INSTALLATION

A. Wiring Installation

1. Wiring methods and materials for panels shall be in accordance with the NEC requirements and industry practices.

2. Wires shall be run in plastic wireways except (1) field wiring, (2) wiring between mating blocks in adjacent sections, and (3) wiring from components on a swing out panel to components on a part of the fixed structure.

3. Wire shall be neatly grouped using nylon tie straps and shall be fanned out to terminals. Wiring to run from components on a swing out panel to other components on a fixed panel shall be made up in tied bundles. These bundles shall be tied with nylon wire ties and shall be secured to panels at both sides of the hinge loop so that conductors are not strained at the terminals.

4. Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and be secured to the inside face of the panel using adhesive mounts.

5. Splicing of wires shall be kept to a minimum and only if the wire cannot be replaced. Splicing shall be either soldered or pressure crimped type. Data and communication wires/cables shall not be spliced.

6. Wire nuts shall not be used.

B. Wiring Termination

1. All field wiring shall terminate at a terminal block in the enclosure. Field wiring shall be terminated first at the field interface terminal block and then wired to the devices/instrument or PLC inside the panel. In general, field wiring shall not be wired directly to the panel mounted device. Fiber cables, copper communication cables, and field bus cables should be managed by patch panel or marshalling module unless specifically indicated otherwise on the contract drawings.

2. Terminals and fuses for each conductor and shield drain wire of a twisted shielded pair or triad cable shall be mounted consecutively next to each other.

3. Terminal blocks shall be grouped based on their function and voltage. Each group of terminal blocks shall be located in the panel to provide easy access and to minimize internal wiring.

4. Terminal blocks for control signals (24Vdc or 120Vac) shall be grouped separately from the power terminals blocks (24Vdc or 120Vac)

C. Each terminal and wire connection shall be tagged in accordance with the approved shop drawings or the OWNER'S standard tagging/numbering, if available.

D. Conduit Penetrations

1. Conduit penetrations in cabinets installed outdoors or areas subject to washdown shall be made on the bottom or side of the panel, never through the top unless authorized by the Engineer in writing.

2. Gaskets and sealing materials shall be installed at each conduit cutout as required.

3.03 CALIBRATION, TESTING, AND INSTRUCTION

1. General: Calibration, testing, and instruction shall be performed in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 71 00 – FLOW MEASUREMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall furnish and install all in-line liquid flow measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 - Process Control and Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control and Instrumentation Systems

C. Reference Standards

American National Standards Institute (ANSI)	
ANSI 150	(87th Edition, 1997) Office Machines and Supplies - Business Machines, Data Processing Equipment, and Business Forms - Character and Line Spacing
ANSI Z540.1	(1994; R 2002) Calibration Laboratories and Measuring and Test Equipment - General Requirements
International Organization for Standardization (ISO)	
ISO 10012-1	(1st Edition, 1992) Quality Assurance Requirements for Measuring Equipment - Part 1: Metrological Confirmation System for Measuring Equipment
National Electrical Manufacturers Association (NEMA)	

1.03 CONTRACTOR SUBMITTALS

A. General: The Contractor shall furnish submittals in accordance with Section 40 91 00 - Process Control and Instrumentation Systems

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems

1.05 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 GENERAL

A. All devices specified herein shall conform to the requirements of the Contract Documents.

2.02 MAGNETIC FLOW MEASURING SYSTEMS

A. Magnetic Flowmeter (Tube Type):

1. Magnetic flowmeter systems shall be of the low frequency electromagnetic induction type and produce a DC pulsed signal directly proportional to and linear with the liquid flow rate. Complete zero stability shall be an inherent characteristic of the flowmeter system. Each magnetic flow metering system shall include a metering tube, signal cable, and transmitter. The metering tube shall be constructed of 304 stainless steel with flanged connections, have at least 2 diametrically opposed, bullet-nosed, self-cleaning electrodes, a liner material recommended by the manufacturer for the meter's intended service as described in these documents, a meter housing rated for NEMA 6 submergence conditions, and a meter coating consisting of epoxy painted finish.

2. The signal converter/transmitter shall use a DC pulse technique to drive flux-producing coils and convert the DC pulse signal from the tube to a 4-20 mA signal. The signal converter/transmitter shall have a backlit alphanumeric display housed in a NEMA 4X enclosure. It shall have integral zero return to provide a constant zero output signal in response to an external dry contact closure, an integral calibration self-test feature to verify proper operation of the electronics, high and low alarms and an automatic zero adjustment. The transmitter installation shall support integral or remote mounting (up to 300ft). Meter package shall include (2) corrosion resistant grounding rings constructed of the same material as the electrodes.

3. Flow tube shall be rated for pressures up to 1.1 times the flange rating of adjacent piping. System shall be rated for ambient temperatures of 30 to +65 degrees C. Meter and transmitter housings shall meet NEMA 4X/IP66 requirements as a minimum. When meter and transmitter are located in classified explosion hazard areas, the meter and transmitter housings shall be selected with rating to meet the requirements for use in those areas. Where the flow tube is subject to submergence through installation in a meter vault or similar location, the flow tube assembly shall be rated NEMA 6P/IP68, and electronics shall be factory sealed against moisture intrusion. The use of field kits for modifying NEMA 4/4X/IP66 flow tubes to submergence duty shall not be acceptable. The associated transmitter shall be located in an area not subject to submergence.

4. The meter shall be equipped with non-removable electrodes constructed of Hastelloy C. The meter shall support measurement and totalization of bi-directional flow. Installation parameters shall be as follows:

   a. Minimum 5 pipe diameters of straight pipe upstream

   b. Minimum 2 pipe diameters of straight pipe downstream

   c. Horizontal mounting or vertical mounting with upward flow only

   d. Support for lines sizes from 1-inch to 120-inches

5. Each flow metering system shall be hydraulically calibrated at a facility which is traceable to the US National Bureau of Standards. The calibration procedure shall conform to the requirements of MIL-STD-45662A and/or the more recent ANSI/NCSL Z540-1 or ISO 10012-1 requirements. A real-time computer-generated printout of the actual calibration data indicating apparent and actual flows at 20, 40, 60, 80, and 100 percent of the calibrated range shall be submitted to the Engineer at least 14 days prior to shipment of the meters to the project site.

6. The flow metering system shall conform to the following technical specifications:

	1. (1) 4-20 mA into 600 ohms minimum; Time Constant = 0.5 to 100 seconds; galvanic or optic isolation
	2. Scaled pulsed output for totalization
	3. HART protocol compatible
Accuracy:	± 0.25% of flow rate from 10 to 100% full scale
Repeatability:	± 0.05% at ± 0.0008 ft/s
Environmental Limits:	- 10 to + 60º C
Power Consumption:	20VA or less
Power Requirements:	110 VAC or 24Vdc, +/- 10%
Accessories:	1. Furnish and install stainless steel sunshield for outdoor/exposed transmitter.

2. Furnish remote mount flow transmitter with a minimum cable length of 50 feet where indicated on contract drawings.

3. Provide stainless steel stanchions for mounting remote transmitter no less than 4 feet above grade (reference mounting details on Installation Detail sheets).

4. Provide manufacturer digital calibration verification unit with necessary accessories to interface with the furnished magnetic flow meter.

5. Furnish one spare spool piece for every size magmeter supplied.

Magnetic flow measuring systems shall be as manufactured by:

1. Endress & Hauser – Model Promag W400 for water applications; Model Promag P300 for chemical applications

2. Rosemount 8700 Series

3. Or Equal

Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

2.03 ROTAMETER LIQUID FLOW MEASURING SYSTEMS

A. General

1. Rotameters in chemical solution lines and where indicated shall have vertical bottom Inlets and top outlets with ANSI 150-lb flanged ends for vertical mounting.

2. The meters shall have Hastelloy C floats, 10-inch-long scales, and a range of 10:1 with an accuracy of plus or minus 2 percent. Meters shall be rated for a minimum working pressure of 150 psi. Flanged rotameters for chemical solutions and where indicated shall be calibrated in gallons per minute.

3. The bodies shall have union ends for ease of maintenance, polysulphone tubes, aluminum or brass end fittings, Type 316 stainless steel internal parts, and scales suitable for the indicated capacity range.

4. The meters shall have an accuracy of not less than plus and minus 5 percent over the capacity range indicated.

B. Application Requirements

1. Meters in air and pump seal flushing lines shall be of the modified rotameter design with screwed ends, spring-loaded pistons, and union bodies for mounting in any position.

2. For activated carbon solution, bodies shall be Type 316 stainless steel construction with magnetically actuated float and scale.

3. For other chemicals, bodies shall have Type 316 stainless steel ends with heavy borosilicate glass tubes and packing glands or other best suitable material.

4. Rotameters with NPT screwed ends for water, air, and fuel gas service shall be calibrated in gallons per minute or cubic feet per minute. The scales shall be suitable for the capacity ranges indicated.

C. Approved Manufacturers:

1. Chemicals: Brooks GT1600 Series, Krohne VA40 or equal.

2. Water service: Hedland-Badger variable area "In-Line" Meters, Krohne H250H or equal.

3. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

PART 3 -- NEMANEMANEMAEXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.05 PRECOMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. On-site supervision shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. On-site performance tests shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record drawings shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. Acceptance shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 71 79 – FLOW SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall furnish and install all in-line liquid flow detection systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 - Process Control and Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control and Instrumentation Systems

1.03 CONTRACTOR SUBMITTALS

A. General: In addition to the Shop Drawing requirements of Section 40 91 00 - Process Control and Instrumentation Systems, the Contractor shall furnish submittals in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.05 MANUFACTURER’S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 PADDLE FLOW SWITCHES

A. Paddle switches shall be activated by paddles in a pipe flow stream. Wetted materials shall be 316 SS. Minimum pressure rating shall be 250 psi. Unit shall have two SPDT switches rated 20 VA minimum. The actuation point between "flow" and "no flow" shall be adjustable. Flow switches shall be suitable for use in the indicated pipe sizes and shall have a 1 1/2-inch MNPT process connections.

B. Flow switches shall be installed horizontally and upright with threaded tee connection with no less than 5 pipe diameters upstream and downstream of the instrument. Flow switches shall be rated NEMA 4X or NEMA 7 as required by the installation area classification.

C. Flow switches shall be as manufactured by:

1. McDonnell & Miller Series FS7-W, FS7-4W or FS7-4E (depending on area classification)

2. Or Engineer approved equal.

D. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

2.02 THERMAL FLOW SWITCHES

A. Thermal flow switches shall be thermal dispersion type with no moving parts. Flow shall be detected by measuring the differential temperature between two RTD’s while maintaining a constant current to the heater. The probes, electronic circuits, and relay shall all be part of an integral unit with a non-ferrous cast housing. Wetted parts shall be constructed of 316SS or Hastelloy C depending on chemical compatibility with the process. In horizontal pipe runs, the unit shall be side mounted. All switches shall be equipped to function in an environment where the probes are not always immersed. Output relay shall be configurable to energize on increasing or decreasing flow and have (1) DPDT or (2) SPDT contacts rated 2A, 120 VAC minimum. Contact transfer point shall be field adjustable from .003 -19 gpm in water. Response time shall be adjustable from 0.5 to 150 seconds. The trip flow point shall not be affected by process fluid changes in the range of 32 to 140 degrees F and shall have a repeatability of plus or minus 5 percent. The contact unit shall operate within the indicated repeatability in an ambient temperature range of 25 to 120 degrees F. The unit shall have a pressure rating of 150 psi or greater and shall be suitable for installation in pipe sizes of 0.5-inch diameter and greater. Unit shall include 120V AC power supply in a stainless steel NEMA-4X box.

B. Thermal flow switch with flanged fittings (material to match installation pipe) shall be as manufactured by:

1. Fluid Components, Inc. Model FLT93L Series (inline model) or Model FLT93C (insert type)

2. Or Engineer approved equal.

C. Thermal Flow Switches shall be provided for all eyewash/shower flow detection applications depicted in the contract drawings, appropriately rated to detect minimum flow associated with eyewash operation only. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

PART 3 -- EXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.05 PRECOMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. The on-site supervision of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. The performance testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record Drawings shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training for all equipment and software shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. All acceptance testing shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 72 00 – LEVEL MEASUREMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall provide liquid level measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 - Process Control and Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control and Instrumentation Systems

1.03 CONTRACTOR SUBMITTALS

A. The Contractor shall furnish submittals in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.05 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 NEMANEMANON-CONTACT RADAR LEVEL MEASUREMENT

A. Where non-contact radar types are indicated (excluding sonic), time-of-flight radar level measuring systems shall consist of an electronic controller-transmitter, a non-

contact signal rod-antenna, interconnecting cables and remote level indicator (as shown on the contract drawings). The controller-transmitter shall generate the radar impulse, detect the return echo, and convert the elapsed time to a level or volume. The measurement shall not be affected by changing media, temperature changes, gas blankets, or steam. The transmitter shall include functions to suppress interference echoes that may be produced by edges or weld seams and shall support K-band and/or C-band frequencies. The antenna performance shall not be affected by condensation build-up. The controller-transmitter shall have the following features: solid state design, integral level indicator (where indicated on the contract drawings), 2-wire loop power, 4-20 mA output signal linearly proportional to the calculated level or volume and HART protocol compatibility. Measuring error shall be no greater than 0.1% of measuring range with a resolution of 0.03% of measuring range. Upon detection of sensor failure, the transmitter shall be configured to immediately reduce output to 3.8mA. The radar level measurement assembly, including transmitter, antenna, and antenna horn, shall be constructed of corrosion resistant material suitable for use in a Class 1 Division 1 hazardous area and installed in an intrinsically safe manner.

B. Radar level measuring systems shall be manufactured by:

1. Endress & Hauser Micropilot FMR5x Series with FHX 50 NEMA 4X remote display and up to 100-ft of manufacturer cabling.

2. Rosemount 5408 Series with Model 751 NEMA 4X remote field signal indicator and up to 100-ft of twisted shielded cabling.

3. Or Engineer approved equal.

C. Instrument shall be furnished with manufacturer recommended 316L SS mounting bracket. Note: where used to measure the level of an aerated surface, the transmitter shall include the advanced dynamics option (or Rosemount equivalent) to ensure measurement accuracy and repeatability within manufacturer's published specification. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

PART 3 -- NEMANEMANEMAEXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.05 PRE-COMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. The on-site supervision of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. The performance testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record Drawings shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training for all equipment and software shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. All acceptance testing shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 72 76 – LEVEL SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall provide level detection switches, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 - Process Control and Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control and Instrumentation Systems

1.03 CONTRACTOR SUMITTALS

A. The Contractor shall furnish submittals in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.05 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 FLOAT TYPE LIQUID LEVEL SWITCHES

A. Liquid level (mercury-free) switches shall be the side mounted float actuated type. Float switches shall be SPDT and shall consist of a fixed sealed reed switch actuated

by a floating magnet. Level switches shall be flange or plug mounted to suit field requirements. Process wetted materials shall be Teflon.

B. Liquid level switches shall be manufactured by MAGNETROL “TUFFY” or Engineer approved equal. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

2.02 TIPPING FLOAT LEVEL SWITCHES

A. Tipping float (mercury-free) level switches shall consist of a switch, a moving float, and a connecting cable which is anchored at the midpoint of a differential band. As the level rises and falls, the float rights itself or inverts causing switching actions. The cable anchoring point shall be protected by strain relief. The hermetically sealed switches shall be SPDT with a minimum rating of 10 Amps at 120 VAC. Process wetted materials shall be Teflon.

B. Tipping float level switches shall be as manufactured by:

1. MAGNETROL Model T10 for non-hazardous locations

2. MAGNETROL Model T20/21 for hazardous Class I Division 1 locations

3. Or Engineer approved equal.

C. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

2.03 VIBRONIC LEVEL SWITCHES

A. The level switch shall operate on the frequency shift tuning fork principle using a two-tine fork assembly and a bi-morph piezoelectric system. The presence of a liquid or slurry shall shift the resonant frequency of the fork assembly below a fixed set point triggering a state change in the switch output. The switch shall introduce no electrical energy into the process being measured. The fork assembly shall be 1.5 inches in length, mounted on an extension from 6 to 115 inches in length, and shall be capable of being mounted vertically or horizontally. The level switch shall be of an integral field mountable self-contained design and shall not have any calibration controls or calibration requirements. Switch point accuracy shall be within 0.004-inches. Gas bubbles, foam, dielectric changes, conductivity changes shall not compromise the ability of the level switch to reliably indicate liquid and slurry levels. The switch shall reliably indicate liquid and slurry levels with viscosity ranging from 0 to 10000cP and density variations from 0.5 to 1.7 SGU. The switch shall reliably operate with hard build-up equivalent to 0.15 inches of calcium carbonate.

B. All wetted parts, including the fork assembly and extension shall be constructed of 316L SS and mounted into the process via a one-inch NPT threaded boss. The switch shall provide continuous self-monitoring of its sensing components and indicate when a failure or fork corrosion has been detected (where indicated on the drawings). The switch shall operate with process temperatures ranging from -40 to 300 degrees F and pressures ranging from vacuum to 930 psi. The switch shall have a NEMA 4X dual-compartment housing rated for Class I Division II installation where indicated. The electronics housing shall be epoxy coated aluminum. Cable entries will be through NPT conduit fittings.

C. The level switch shall have all electronics in the form of module inserts that can be field installed or interchanged without effect on switch performance or need to recalibrate, and without removing the sensor from the process. Electronics will have an LED indicating switch state, as well as a power LED indicator. An on-board toggle switch will allow field selection of max or min detection. A pressure tight feed-through from the sensor to the electronics housing will be available to provide a 2nd line of defense in the case of sensor damage.

D. The level switch shall be as manufactured by

E. Endress & Hauser Liquiphant M FTL 50 Series

F. Rosemount 2120 Vibrating Fork Level Switch

G. Approved equal.

H. Refer to Appendix A of Section 40 91 00 - Process Control and Instrumentation Systems for the complete instrument schedule.

PART 3 -- EXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.05 PRECOMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. The on-site supervision of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. The performance testing of all devices shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record Drawings shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training for all equipment and software shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. All acceptance testing shall conform to the requirements of Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 73 00 – PRESSURE, STRAIN, AND FORCE MEASUREMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall furnish and install all pressure measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 – Process Control and Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures, for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control and Instrumentation Systems

1.03 CONTRACTOR SUBMITTALS

A. General: In addition to the Shop Drawing requirements of Section 40 91 00 – Process Control and Instrumentation Systems, the Contractor shall furnish submittals in accordance with Section 40 91 00 – Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

1.05 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 PRESSURE GAUGES

A. Pressure gauges shall be 4-1/2 inches in diameter, liquid-filled, bottom connected, with white laminated dials and black graduations. Windows shall be shatterproof glass. Gauges shall have a blowout disc and be encased in phenolic, steel or cast iron.

Measuring element shall be a stainless-steel bourdon tube with welded, stress-relieved joints. Sockets shall have wrench flats. Movement shall be rotary geared, all stainless-steel material. All pressure gauges shall be provided with a pulsation snubber constructed of 316 stainless steel and a ball isolation valve. Accuracy shall be plus or minus 0.5 percent range to 150 percent of the working pressure or vacuum of the pipe or vessel to which they are connected.

B. Pressure gauges shall be manufactured by:

1. **Ashcroft 1279**

2. **Ametek Solfrunt Series 1900**

3. **Or equal.**

C. Unless noted otherwise, all pressure gauges represented on the P&ID contract drawings are to be provided by the Contractor. Refer to Appendix A of Section 40 91 00 – Process Control and Instrumentation Systems for the complete instrument schedule.

2.02 ELECTRONIC PRESSURE TRANSMITTERS

A. Components: Electronic transmitters shall be of the pressure type and consist of a capsule assembly, bottom works, weather-proof and bug-proof atmospheric vent plug assembly, drain plug, cover flange, process connector and connection, Teflon gaskets, amplifier unit, integral indicator, terminal box with cover, block and bleed valves, and conduit connections. Electronic transmitters shall be housed in a NEMA 4X enclosure. Flow Indicating Transmitters (FIT) shall be provided with three valve stainless steel manifolds. Level Indicating Transmitters (LIT) and Pressure Indicating Transmitters (PIT) shall be provided with one valve of stainless steel manifolds.

B. Operating Principles: Pressure applied to the transmitter shall be transmitted by a sealed fill fluid of a sensing diaphragm. The sensing diaphragm and the sensor body shall function respectively as the moving and fixed electrodes of a capacitor. As the applied pressure causes the diaphragm to move, the capacitance of the cell shall change.

C. Performance Requirements

1. The transmitter enclosure (top-works) shall be rotatable to facilitate access to the electronics with an over-rotation stop to prevent damage to sensor wires.

2. The amplifier unit shall convert the change in capacitance to a 4-20mA DC signal, 2-wire type, with an allowable loop load of no less than 575 ohms.

3. Transmitter design shall incorporate voltage surge and RFI protection.

4. Static pressure rating shall be a minimum of 500 psig. The maximum overrange pressure limit shall be a minimum of 150 percent of the maximum range.

5. Span shall be adjustable over a minimum of a 7:1 range. External adjustments shall include zero and span.

6. Output signal damping shall be provided as an internal adjustment. Square root extraction circuitry, as will be required for venturi flow measurement applications,

shall be provided as an option which can be added or removed from the transmitter.

7. All equipment shall be suitable for an ambient operating range of minus 40 degrees F to 212 degrees F.

8. All block and bleed valves shall be constructed of 316 stainless steel. Bolts for process covers and process connectors shall be of the same material as that specified for the process covers.

9. The top-works shall be constructed of low copper die-cast aluminum and finished with epoxy paint.

10. The integral indicator shall have a linear scale and be calibrated in process units. Power supply shall be 24 VDC.

11. Accuracy, including linearity and repeatability, shall be a plus or minus 0.2 percent of the span. Hysteresis shall be limited to 0.05 percent of the span. Drift, over a six-month period, shall not exceed 0.1 percent of reference span. Ambient temperature effect shall be limited to no more than plus or minus 0.5 percent of maximum span per 100° F.

12. Transmitter is to utilize “Smart” technology which employs a hand-held configuration terminal and complies with HART protocol.

D. Materials: All wetted parts including block and bleed valves parts shall be constructed of 316 stainless steel.

E. Manufactures (absolute pressure / gauge pressure):

1. **Endress & Hauser Cerebar S PMP71 or PMP75**

2. **Rosemount 3051CG or 3051TG**

3. **Or equal.**

F. Refer to Appendix A of Section 40 91 00 – Process Control Instrumentation Systems for the complete instrument schedule.

2.03 DIAPHRAGM SEALS FOR PRESSURE MEASURING SYSTEMS

A. Components: Diaphragm seals shall consist of bottom housing, lower ring, diaphragm capsule, fill screw, flushing connection, and a top housing.

B. Operating Principles: The diaphragm seal shall attach to the inlet connection of a pressure instrument to isolate its measuring element from the process fluid. The space between the diaphragm and the pressure element shall be completely filled with a suitable liquid. Displacement of the liquid fill in the pressure element through the movement of the diaphragm shall transmit process pressure changes directly to a gauge, transmitter, switch, or other pressure instrument. The diaphragm seal shall have a removable bottom housing to permit the servicing and refilling. The seal shall include a flushing port and fill / bleed connection.

C. Materials: All exposed surfaces, housings, and diaphragm shall be constructed of 316 stainless steel.

D. Pressure diaphragm seals shall be **Ashcroft 100** or equal for non-corrosive applications. For chemical processes or corrosive environments: diaphragm seals shall be manufactured by **Plastomatic GGS / GGSE** (PTFE or Viton) or **Ashcroft 300** (PTFE or Viton). Contractor to furnish where shown on the P&IDs.

PART 3 -- EXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.05 PRECOMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. The on-site supervision of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. The performance testing of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record Drawings shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training for all equipment and software shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. All acceptance testing shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 73 36 – PRESSURE AND DIFFERENTIAL PRESSURE SWITCHES

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall furnish and install all pressure detection systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 – Process Control and Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control and Instrumentation Systems
40 73 00	Pressure, Strain, and Force Measurement

1.03 CONTRACTOR SUBMITTALS

A. General: The Contractor shall furnish submittals in accordance with Section 40 91 00 – Process Control and Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

1.05 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of 40 91 00 – Process Control and Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 ADJUSTABLE PRESSURE SWITCH

A. Unit shall be operated by a diaphragm and plunger actuating a snap switch (mercury switches shall not be accepted). Pressure switch shall have dual adjustments with two SPDT contacts rated for a minimum of 5 Amps at 120VAC. The dead band shall be adjustable up to 100 percent of the full scale. Set points shall fall between 20 and 80 percent of the adjustable range. The diaphragm shall be Buna-N, unless otherwise indicated, and the lower housing shall be 316 stainless steel with a ¼-inch bottom sensing connection, unless otherwise indicated.

B. Adjustable pressure switches shall be manufactured by Ashcroft, Series PPxN7 for NEMA 7/9 applications and Series GPxN4 for NEMA 4X applications or Engineer approved equal.

C. Refer to Appendix A of Section 40 91 00 – Process Control and Instrumentation Systems for the complete instrument schedule.

2.02 DIAPHRAGM SEALS FOR PRESSURE MEASURING SYSTEMS

A. See Section 40 73 00 - Pressure, Strain, and Force Measurement for diaphragm seals.

PART 3 -- EXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.05 PRECOMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. The on-site supervision of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. The performance testing of all devices shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record Drawings shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.09 TRAINING

A. Training for all equipment and software shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

3.10 ACCEPTANCE

A. All acceptance testing shall conform to the requirements of Section 40 91 00 – Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 75 00 – PROCESS LIQUID ANALYTICAL MEASUREMENT

PART 1 -- GENERAL

1.01 THE REQUIREMENT

A. General: The Contractor shall furnish and install all process analyzer measuring systems, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 91 00 – Process Control Instrumentation Systems apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See 01 33 00 for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

40 91 00	Process Control Instrumentation Systems

1.03 CONTRACTOR SUBMITTALS

A. General: The Contractor shall furnish submittals in accordance with Section 40 91 00 – Process Control Instrumentation Systems.

1.04 QUALITY ASSURANCE

A. General: The accuracy of each instrumentation system or loop shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

1.05 MANUFACTURER'S REPRESENTATIVE SERVICES

A. General: Manufacturers' representative services shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

1.06 PRODUCT HANDLING

A. General: Product handling shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

1.07 GUARANTEE

A. General: Guarantees shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

PART 2 -- PRODUCTS

2.01 GENERAL

A. Signal Output: Analyzers shall be “smart” type and shall support remote configuration and calibration. Analyzers shall be interfaced to the plant control system using current regulated 4-20 mA HART protocol (driving 0 to 600 ohms). The Contractor shall perform a complete configuration check of each transmitter prior to site installation.

B. Power Input: Analog signal analyzers shall be fully isolated 2-wire type (i.e., loop-powered) wherever possible. However, if separate power is required for a given device, 24VDC (delivered from the signal handling cabinet) will be the preferred installation approach. If neither type is available for a given application, the analyzer shall be fully isolated 4-wire type with power supply of 120 volts plus and minus 10 percent, 60 Hz plus and minus 5 percent.

C. Ambient Conditions: Analyzers shall be suitable for continuous automatic on-line analysis of the indicated parameter under the conditions indicated.

1. Equipment shall operate satisfactorily at ambient temperatures between 0 degrees and 132 degrees F or shall be provided with isothermal enclosures so that accuracies will not exceed one percent of span.

2. Process fluid temperatures will range between 32- and 120-degrees F unless indicated otherwise.

D. Sample Flow: Flow to non-inline analyzers (generally wet panel-mounted) shall be monitored by a thermal flow switch. Detected loss of flow shall result in generation of control system process alarms. Samples shall not pass through housings containing electronics unless specifically indicated otherwise.

E. Local Indication: Each analyzer shall be provided with local indicator scaled to match the indicated process units (refer to Section 40 91 00 – Process Control Instrumentation Systems Appendix A – Instrument List).

F. Calibration: HART transmitters shall be scaled and configured using the appropriate smart calibration device. Standard 4-20mA analyzers shall be fitted with calibration connections at the analyzer as required by the manufacturer.

G. Single manufacturer: All electrodes, fittings, and transmitters on analyzers measuring the same parameter shall be products of a single manufacturer.

2.02 LOW/HIGH RANGE TURBIDITY MEASURING SYSTEMS

A. The turbidimeter shall be a microprocessor-based, continuous-reading, on-line nephelometric instrument meeting all design and performance criteria specified by USEPA method 180.1. Light shall be directed through the surface of the sample, and the detector shall be immersed in the sample, eliminating glass windows and flow cells. Optical components shall be mounted in a sealed head assembly that can be removed easily for calibration/service, without disturbing sample flow. The turbidimeter body shall be constructed of corrosion-resistant polystyrene and shall include an internal bubble trap to vent entrained air from the sample stream. The turbidimeter shall offer

the choice of formazin-based (20 or 1 NTU) or instrument comparison-based calibration methods.

B. Accuracy shall be ± 2% of reading or ± 0.020 NTU (whichever is greater) from 0 to 40 NTU (Nephelometric Turbidity Units), and ± 5% of reading from 41 to 2000 NTU. Resolution shall be 0.001 NTU from 0 to 40 NTU, 0.01 NTU from 41 to 999 NTU, and 0.1 NTU from 1000 to 2000 NTU, and repeatability shall be better than ± 1.0% of reading or ±0.002 NTU (whichever is greater). User selectable signal averaging, bubble rejection, alarm and recorder output hold, and self-test diagnostics shall be provided.

C. Calibration shall be based on Formazin via comparison to a laboratory turbidimeter or with reflectance rods which are furnished as an accessory. The control unit shall be capable of offsetting the turbidity of pure water to read 0.0000 on particle free water. An auto-ranging digital display shall read from 0 to 100 NTU, and the output shall be capable of driving an 800-ohm load. The output shall be programmable over any portion of the output range, and self-test diagnostics shall be provided to indicate malfunctions. The control unit shall be provided in a wall mounted fiberglass enclosure which permits unobstructed viewing of all readouts. The turbidimeter shall have a 2-year Manufacturer's warranty.

D. Interface Module: The graphical interface unit shall be a microprocessor-based device capable of functioning in a single sensor. The interface unit shall allow operators to control sensor functions with user-friendly, menu-driven software, and shall provide datalogging of measurement data for 1 hour, 24 hours or 30 days, and the capability to transfer data to a computer or printer via an RS232 serial input/output device. The interface unit and separate DC power supply shall be housed in NEMA-4X (indoor) industrial plastic enclosures, and the power supply shall automatically accept input in the range of 95 to 240 Vac, 50/60 Hz. The Interface module shall be provided with a 4-20 mA signal output module and a PS1201 power supply. The unit shall also be equipped with (2) fully adjustable SPDT dry relay contacts.

E. Low Range Turbidimeter (0-40NTU) shall be as manufactured by:

1. Hach Model TU5300 with sc5400 transmitter

2. HF Scientific MTOL Plus Online Turbidimeter with manufacturer recommended calibration kit

3. Endress and Hauser Turbimax Model CUE22 with manufacturer recommended calibration kit

4. Engineer approved equal.

F. High Range Turbidimeter (0-2000NTU) shall be as manufactured by:

1. Hach Model Surface Scatter 7 sc with sc4500 transmitter

2. Engineer approved equal

G. NEMApH/Temperature Sensor

1. The pH sensor shall be of the combination pH, reference electrode type housed in a molded polypropylene body with large area reference junction. The sensor shall have a 100-ohm RTD for automatic temperature compensation over the range of 0-100 °C up to 150 psig. Probes shall be submersion-type, flow-through or in-line configuration as indicated on the P&IDs with water-tight, quick release sensor-to-cable connector. Sensor manufacturer's flow-through cell shall be furnished to support wet-panel installations; UV-resistant, water-tight 10m (nominal) sensor cable shall be furnished to support open-tank submersion applications. The pH sensor shall be as manufactured by:

    a. Rosemount Analytical, Uniloc Model 396 (complete with an annular titanium solution ground for sensor diagnostic)

    b. Endress and Hauser Model CPS11D (pH)

    c. Hach pHD sc digital pH sensor

    d. Engineer approved equal.

H. ORP Sensor

1. The ORP sensor shall be of the combination pH reference electrode type housed in a molded sealed, watertight tefzel body. The sensor shall be equipped with a triple junction reference. The sensor shall have an accuracy of ± 1.0 mV, repeatability of ± 1.0 mV, and a stability of ± 1.0 mV/month (non-cumulative). Probes shall be submersion-type, flow-through or in-line configuration as indicated on the P&IDs with water-tight, quick release sensor-to-cable connector. Sensor manufacturer's flow-through cell shall be furnished to support wet-panel installations; UV-resistant, water-tight 10m (nominal) sensor cable shall be furnished to support open-tank submersion applications. The ORP sensor shall be as manufactured by:

    a. Rosemount Analytical, Uniloc Model 389

    b. Endress and Hauser Model CCS12D (ORP)

    c. Hach pHD sc digital ORP

    d. Engineer approved equal.

I. General: Integral sensor preamplifier shall be supplied as required by manufacturers per installation requirement. Transmitters and probes shall be of the same manufacturer. Transmitters and sensors shall be from the same manufacturer. Refer to Section 40 91 00 – Process Control Instrumentation Systems Appendices for the complete instrument schedule.

2.03 COLORIMETRIC FREE AND TOTAL CHLORINE RESIDUAL MEASURING SYSTEMS

A. Analysis System

1. The analysis system shall measure free or total chlorine by a colorimetric N, N-diethyl-p-phenylenediamine (DPD) method. Following application-specific sample

conditioning (i.e., forced flow through a membrane filter), reagent is added to a sample ratio resulting in a characteristic color change. For each analyzer, reagents shall be provided for free chlorine or total chlorine analysis as required. An LED source is used to pass light through the sample at a wavelength correlated to total chlorine. The intensity of the light received by (or the absorbance detected by) the photometer is proportional to the concentration of total chlorine. The analyzer serves to calculate concentration based on the proportion of light absorbed by the sample. The analysis system shall include automatic temperature and turbidity compensation. Assuming a minimum flow rate of 5 mL/min with conductivity greater than 50 µS/cm, the entire minimum permissible measuring period (including reaction time, rinse cycles, filling time, sampling time, and reagent latency) shall be no longer than 10 min.

2. Precision: Maximum error shall be ± 2% of the measuring range. Supported measuring ranges shall be from 0 to 5 ppm free or total chlorine.

3. Transmitter: The system shall be housed within an ABS plastic IP62-rated enclosure with polycarbonate windows and gasketed doors. The system shall support a single or dual channel arrangement, 4-20 mA each, proportional to the measured variable. Operating ambient temperature range of 41°F to 104°F (at 10% to 95% humidity, non-condensing) shall be supported; however, system installation shall mitigate strong diurnal temperature fluctuations. The system transmitter shall include one limit dry contact per channel plus one general alarm dry contact. Integral LED display will indicate the measured value and operating keys, and status LEDs will support secure user configuration. Required power = 120 VAC.

4. The colorimetric chlorine residual analysis system shall be manufactured by:

   a. Hach CL17sc Colorimetric Chlorine Analyzer

      1) Free Chlorine: Analyzer kit 8572700 with free chlorine reagents

      2) Total Chlorine: Analyzer kit 8572800 with total chlorine reagents

   b. Engineer approved equal.

B. General: Analysis Systems shall be furnished complete with a one-year supply of spare membrane assemblies, sensor electrolyte (as applicable), active/inactive reagents (as applicable), pre-conditioning filters, and maintenance kit. Transmitters and sensors shall be of the same manufacturer. Refer to Section 40 91 00 – Process Control Instrumentation Systems Appendices for the complete instrument schedule.

PART 3 -- NEMANEMANEMANEMANEMANEMANEMANEMANEMANEMANEMAEXECUTION

3.01 GENERAL

A. Electrical interface and code compliance shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.02 CALIBRATION

A. The calibration of all devices shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.03 INSTALLATION

A. The installation of all devices shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.04 LOOP TESTING

A. The loop testing of all devices shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.05 PRE-COMMISSIONING

A. The pre-commissioning of all devices shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.06 ON-SITE SUPERVISION

A. The on-site supervision of all devices shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.07 PERFORMANCE TESTING

A. The performance testing of all devices shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.08 RECORD DRAWINGS

A. Record Drawings shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.09 TRAINING

A. Training for all equipment and software shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

3.10 ACCEPTANCE

A. All acceptance testing shall conform to the requirements of Section 40 91 00 – Process Control Instrumentation Systems.

END OF SECTION

1. LOCAL: The term “LOCAL” means “in the field”, i.e., at the physical location of the equipment. Local control means at the equipment or control from the MCC starter panel.

2. REMOTE: The term “REMOTE” means away from the equipment. Remote control means the ability to control the equipment at the control panel/PLC or from the HMI away from the equipment or away from the MCC.

3. Local Control Panel (LCP): refers to the presence of a field-situated panel, which serves as a control location. Usually, this panel contains the PLC.

4. Local Display: This function refers to the display of equipment status or process variable at a location in the field, local to the equipment.

5. Local Interlock: This function refers to the presence of field-situated control logic in which the status of other equipment directly affects the operation and control of the equipment being controlled.

6. Control System Alarms and Status: Variable or status data to be alarmed in the Control Room.

7. Local Alarms: Alarms that are announced in the field.

8. Set Points: Values which are adjustable at the engineer (supervisor) level displays without requiring any software configuration. These values are not adjustable by the operator from the display station. Whenever a LOCAL/REMOTE set point selection is provided, in LOCAL, the set point shall be adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.

C. Control Modes

1. Local Manual Control Mode: This mode enables manual control proximal to the equipment. The equipment is then manually controlled (e.g., START, STOP, OPEN-STOP-CLOSE, etc.) by a local selector switch station by switching it to “HAND” or “OFF,” or “OPEN-STOP-CLOSE.” The control logic and set points in the plant control system PLC are bypassed and do not affect the operation of the equipment. All the controls from the HMI are disabled.

2. Local Automatic Control Mode: This mode enables automatic control that is provided and performed external to the PLC. In some cases, the equipment in the plant is pre-packaged with a Local Control Panel complete with its own automation logic.

3. Remote Manual Control Mode: This mode allows control from the HMI. The operator switches the “Auto/Manual” switch at the HMI to the “MANUAL” position to enable manual operation from the HMI. In this position, the operator is able to “START,” “STOP,” “OPEN,” CLOSE” etc. the equipment, or manually change the control output to the equipment. Consequently, in this position the automatic control logic and set points in the PCS controller are overridden. In this mode, the local control system is also bypassed except for equipment safety interlock.

4. Remote Automatic Control Mode or SCADA Mode: This mode allows control of the equipment from the HMI and PLC. The operator at the control room switches the

"AUTO/MANUAL" switch at the HMI to "AUTO" position to enable PCIS automatic operation. In this mode, the equipment is controlled automatically by the control logic and set points residing in the PLC. The supervisor is able to change operational parameters through the HMI by entering new set points. A control mode status signal will be sent to the PLC to indicate when the PLC is allowed to control the equipment. The PLC shall monitor the control mode status (LOCAL/ REMOTE) and attempt to control only that equipment which is in the REMOTE mode.

D. General Control and Mode Switches Terms

1. "LOCAL-OFF-REMOTE" Switch: For the purpose of this definition and for simplicity, it is assumed that these switches are located at MCC.

    a. LOCAL Position: In this position, equipment automation and control from the control panel/PLC are bypassed. The control is being delegated away from the PLC. Control from the HMI is also disabled.

    b. OFF Position: In this position all equipment control functions are off and disabled.

    c. REMOTE Position: In this position equipment, automation and control are available from the control panel/PLC. An AUTO-MANUAL and a START-OFF-STOP switch (or OPEN-OFF-CLOSE) shall be provided at the operator HMI workstation from which remote manual control is performed.

2. "HAND-OFF-AUTO" Switch: This switch is located usually at the LCP. Control through this switch is performed from the LCP only if the LOCAL-OFF-REMOTE switch at the MCC is in the LOCAL position as discussed above. All the control functions are performed locally and externally to the PLC.

    a. HAND Position: in this position the equipment is started manually.

    b. OFF Position: The equipment is off.

    c. AUTO: In this position, the equipment is automatically controlled locally and external to the PLC by local control hardware.

3. HMI Switches:

    a. For equipment that is controllable from the PLC in either a MANUAL or AUTOMATIC mode, the operator shall be provided with a software "AUTO-MANUAL" selector switch at the operator HMI workstation. This switch is functional only when the LOCAL-OFF-REMOTE switch in the field is in REMOTE position. The following are the AUTO- MANUAL functions:

        1) AUTO – In this position, the operator delegates and enables the automation and control functions of the equipment to be performed at the PLC/control panel in the field. The operator is unable to manually control the equipment from the HMI.

        2) MANUAL – In this position, the operator is able to override the control functions in the PLC and remotely control the field equipment manually from the HMI.

SECTION – 40 90 10 CONTROL STRATEGIES

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor, through the use of the System Supplier, shall provide all PLC-Based Control System (PBCS) application programming required to implement the control strategies described in this section, the functions shown on the Drawings and I/O schedules complete and operable in accordance with the Contract Documents.

B. The control strategies in this section are intended to describe the general operation of the systems and processes and address systems that are required to be installed or modified as part of this project and to describe the general operation of the systems and processes. The control strategies are not intended to be all-inclusive operational procedures for the operation of the complete facility. The Contractor shall make refinements, modifications, and additions to these strategies as needed.

C. The requirements in this section include programming all PLC and Workstation and all other programming of PBCS interface, network, and communication devices.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. The requirements of Section 40 91 00 – Process Control and Instrumentation Systems, Section 40 95 10 – PLC-Based Control System Hardware, and Section 40 95 20 – PLC-Based Control System Software apply and are an integral part to this Section.

C. The Direct Membrane Integrity Testing requirements of Section 46 61 34 Containerized Membrane Filtration System.

1.3 ACTION SUBMITTALS/ INFORMATIONAL SUBMITTALS

A. The PLC submittal shall be provided in accordance with the requirements specified in Section 40 91 00 - Process Control and Instrumentation Systems.

B. Contractor must be aware that the system software submittal in Section 40 91 00 - Process Control and Instrumentation Systems requires a functional design report of the implemented control functions using as a reference the strategies specified in this section.

1.4 FUNCTIONS AND CONTROL MODES

A. The term Plant Control System (PCS) is used as a generic representation of any type of control system, independent of the technology used to control a facility. The control system can be either a DCS or a PLC-based system.

B. Functions

b. A second software switch such as “START-OFF-STOP” or OPEN-STOP-CLOSE,” etc. or as required by the application, shall be provided in the HMI to control the equipment in the field manually from the HMI. Variations of these types of control switches shall be provided for the equipment based on its control application. These switches shall be functional only when the above “AUTO-MANUAL” switch is in “MANUAL” mode.

1.5 CONTROL STRATEGY CONTENTS

A. Control Strategy General Description: The control strategy general description provides a narrative of the process, its related equipment, as well as the function, the philosophy and methodology of the process control. It provides guidelines for programming the control functions. The general description together with detailed loop by loop functional description and other section of the strategy comprise the design criteria of the process control.

B. Detail Loop Description: This part describes the applicable loops in the control strategy and every mode of operation. The narrative should include an explicit description of what each loop monitors and what and how each element in the control loop functions and controlled in various modes of operation. Each loop description contains the required functionality needed to support control system process graphic screens.

C. Common Functions

1. The following list of Common Control Features shall be implemented on all equipment and as stated in the individual control strategies listed within these specifications.

a. The “Soft I/O” signals described in this document are provided for the Contractor’s convenience and represent the minimum signals to be derived for the monitoring and control of the equipment. The Contractor shall provide all necessary additional software-derived signals to meet the control strategies at no additional cost to the Owner.

b. Analog instrumentation failure feature:

1) Out of Range Alarm: All analog inputs shall have a unique instrument failure alarm when the input is below 0 percent or above 100%. This alarm shall be displayed on the HMI as an Out-of-Range alarm.

2) If an analog signal is used to control the operation of the equipment from the PLC, the equipment shall remain running at its last valid set point until the analog instrumentation is stable for a tunable time setting.

c. Unless otherwise stated or shown, all discrete outputs shall be maintained for outputs. For START/STOP PLC functions, the PLC shall issue a maintained START command until a FAIL state is detected or when a STOP command is issued. When a momentary command is required, the PLC shall issue the command for 2 seconds and then remove the signal.

d. Pump Control and Status Discrepancies Programming:

1) In general, for equipment that the PLC is allowed to control, the PLC shall provide a FAIL alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than a tunable time period. In this event, the command shall be removed subsequent to the expiration of the tunable time period.

2) A discrepancy/fail alarm shall be generated for any pump or final control element if a discrepancy exists between a system or operator's command and the device status. For example, the system commands to start ("CALL") and the pump fails to start ("RUN" status report back) within a programmable time delay, then a discrepancy ("FAIL") alarm shall be generated.

3) Likewise, involuntary change in the device's status shall also generate an alarm. For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.

4) A "FAIL" alarm shall not be generated even if the pump is intentionally started or stopped by an operator switching the HMI control switch to "START" or "OFF" position. However, if the operator turns the switch to “START” position and the pump has not started, a fail alarm shall be announced at the control center. Furthermore, if the operator turns off a pump and the pump has not stopped, an alarm shall also be announced at the control center. All fail alarms shall be delayed by an adjustable time delay of 0-90 seconds.

e. All chemical feeders shall be immediately restarted following restoration of power – either from the utility or the generator.

f. Wherever 2 or more pieces of equipment are provided for the same functions, for example air scour blowers, the SCADA system shall alternate the equipment after each use.

g. Where alarms are specified in the control strategy descriptions, alarms shall be initiated from the applicable inputs. If discrete inputs are not available, the specified alarms shall be initiated from the applicable analog input; alarm set points shall be operator adjustable.

h. For all chemical storage tanks, the SCADA system shall calculate volume, amount used per shift, and amount used per day

i. Additional common control and monitoring functions are provided in the “EXECUTION” section of Section 40 95 20 – PLC-Based Control System Software.

1.6 QUALITY ASSURANCE

A. The control strategies shall be tested as part of the factory and field acceptance tests and in accordance with the requirements specified in Section 40 91 00 – Process Control Instrumentation Systems.

PART 2 -- PRODUCTS (NOT USED)

PART 3 -- EXECUTION

3.1 **RAW WATER SYSTEM (EXISTING RAW WATER VAULT, RW FLOW CONTROL VALUT, AND EXISTING FILTERED WATER PUMP STATION)**

A. Reference Drawing: 01I-601, 10I-601, 12I-601.

B. Equipment:

1. Raw Water Pressure Transmitter (10-PIT-0110)

2. Existing Raw Water Vault

   a. Flowmeter (10-FIT-0110)

   b. Existing Pressure Indicating Transmitter (10-PIT-0110)

   c. Pressure Gauges (10-PI-0106, 0107, 1080)

3. Sample Pump (10-P-0120)

4. Rotameter (10-FI-0120)

5. Motorized Modulating Plug Valve (10-MOV-0107)

6. Raw Water Pump Station

   a. Level Switch High (12-LSH-0110)

   b. Level Switch Low (12-LSL-0110)

   c. Level Indicating Transmitter (12-LIT-0110)

C. Description: Raw Water (RW) will be discharged from the existing pipeline through Flow Meter FE-0110 and a modulating Flow Control Valve (MOV-0107). RW will discharge into the Wet Well (WW) of the Raw Water Pump Station (RWPS) shown on drawing 12I-601. Water level in the WW will be measured by Level Indicating Transmitter (LIT-0110), Level Switch High (LSH-0110), and Level Switch Low (LSL-0110).

Flow from the RW System shall be controlled based on the Wet Well water level and the FSP_{CR} generated by the Carson Reservoir level. The Control system will allow the Operator to select a depth (D4) in the Wet Well to establish two Level Bands.

1. Level Band 1 will be from the WW floor at 0-feet depth up to depth D4. When the water surface level is within Level Band 1, MOV-0107 will be 100% open.

2. Level Band 2 will be from D4 up to the depth of LSH-0110. When water level is within Level Band 2, the FSP for RW (FSPRW) will equal the FSP generated by the Carson Reservoir water level FSP_{CR}.

3. When the wet well water level is high and activates LSH-0110, MOV-0107 will be commanded to Close

D. Raw Water Pump Station

1. The Enable / Disable button for the Raw Water System will also be used to control the Raw Water Pump Station. Raw water will be conveyed from the raw water wet well to the membrane container using three pumps in the Raw Water Pump Station shown on drawing 12I-601. The pumps are existing and fixed speed operation. The operator will select the number of pumps to run. If LSL-0110 is activated indicated at low wet well level, the pumps will be de-energized. If LSL-0110 is not activated and FSPRW is a non-zero value, then the selected pumps will run.

E. Local Controls: Local Control for the motorized modulating plug valve shall be valve operator. k mode, and the OPEN or CLOSE push button on the operator is pressed. The valve travel can be stopped by pressing the STOP push button on the valve operator. The valve shall automatically stop when it reaches its open or closed limit switches. The status of the valve shall be monitored by the SCADA system.

F. Local Automatic Control Mode: There are no local automatic controls for the RW (Raw Water) Flow Control Vault or existing Raw Water Pump Station (Filtered Water Pump Station).

G. SCADA Inputs/Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The existing Raw Water Vault has a FLOW status, pH/TEMP status, and TURB status inputs for monitoring at the SCADA HMI.

2. The RW Flow Control Vault has a motorized modulating plug valve (MOV-0107) that will be monitored at the SCADA HMI. The valve shall be open when the LOCAL/REMOTE selector switch on the valve operator is selected to the REMOTE mode, and the OPEN or CLOSE switches on the SCADA system are actuated. The valve shall automatically stop when it reaches its open or closed limit switches. The valve OPEN and CLOSED status shall be transmitted and displayed at the SCADA system for monitoring.

3. The existing Raw Water Pump Station (Filtered Water Pump Station) has a LEVEL status, LEVEL HIGH, and LEVEL LOW inputs for monitoring at the SCADA HMI.

H. SCADA Automatic Control Mode:

1. The control system will have an Enable / Disable button for the Raw Water System. For the Raw Water System to be Enabled, the Membrane Container System must also be Enabled. When the raw water system is disabled, valve MOV-0107 shown on drawing 10I-601 will close.

2. The WTP flow rate will be controlled based on the Level Indicating Transmitter (25-LIT-0120) and the Level Switch High (25-LSH-0120) located in the existing Carson Reservoir shown on drawing 25I-601. The Control system will allow the operator to establish three depths (Floor<D1<D2<D3<LSH) within the Carson Reservoir that will be used to establish four Level Bands (LB). Each LB will have its own Flow Set

Point (FSP) selected by the Operator. It is envisioned that the operator will select values consistent with: FSP1>FSP2>FSP3>FSP4 and that FSP4=0.

a. Level Band 1 will be from the reservoir floor at 0-feet depth up to depth D1. When the water surface level is within LB1, the FSP will equal FSP1 selected by the Operator.

b. Level Band 2 will be from depth D1 up to depth D2. When the water surface level is within LB2, the FSP will equal FSP2 selected by the Operator.

c. Level Band 3 will be from depth D2 up to depth D3. When the water surface level is within LB3, the FSP will equal FSP3 selected by the Operator.

d. Level Band 4 will be from depth D3 up to the level of LSH-xxxx. When the water surface level is within LB4, the FSP will equal FSP4 selected by the Operator.

e. If 25-LSH-0120 is activated, the FSP shall be zero, and the Operator will be notified with an alarm.

3. Flow from the RW System shall be controlled based on the Raw Water Pump Station water level and the FSPCR generated by the Carson Reservoir level. The Control system will allow the Operator to select a depth D4 in the Wet Well to establish two Level Bands. Each LB will have its own Flow Set Point FSPRW established below.

a. Level Band 1 will be from the Raw Water Pump Station floor at 0-feet depth up to depth D4. When the water surface level is within LB1, the FSP for RW (FSPRW) will equal the FSP generated by the Carson Reservoir water level FSPCR.

b. Level Band 2 will be from D4 up to the depth of 12-LSH-0110. The RW flow will be proportionally controlled so when the actual depth Dacutal is at D4, the flow will equal the FSPCR generated from Carson Reservoir and when the level is at the LSH flow shall be zero. When the water surface level is Dactual within LB2, the RW FSPRW will be calculated as follows:

c. FSPRW = FSPCR * (Dactual – DLSH) / (D4 – DLSH)

I. Interlocks: None.

J. SCADA Commands:

1. Raw Water Flow Control Valve Vault Motorized Modulating Plug Valve:

a. Position Setpoint (ZK-0107)

2. Existing Raw Water Feed Pump Station Re-circulation Pumps:

a. Start/Stop Command (HS-0110, 0120, 0130)

K. Existing Mission Telemetry System

1. Existing Raw Water Pressure Transmitter (PIT-0110)

2. Existing Raw Water Pump Station Pumps:

    a. Run (YL-0110A, 0120A, 0130A)

    b. Off (YL-0110B, 0120B, 0130B)

3. Existing Booster Pumps:

    a. Run (YL-0210A, 0220A, 0230A)

    b. Off (YL-0210B, 0220B, 0230B)

L. Key Instruments/Signals Monitored via SCADA:

1. Existing Raw Water Pressure Indicating Transmitter (10-PIT-0110):

    a. Pressure (PI-0110)

2. Existing Raw Water Vault Flow Indicating Transmitter (10-FIT-0110):

3. Flow (FI-0110)Raw Water Flow Control Valve Vault Motorized Modulating Plug Valve:

    a. Ready (YL-0107)

    b. Opened (ZLO-0107)

    c. Closed (ZLC-0107)

    d. Position (ZI-0107)

4. Existing Raw Water Pump Station Re-circulation Pumps:

    a. In Remote (ZL-0110, 0120, 0130)

    b. Run (YL-0110, 0120, 0130)

5. Existing Booster Pumps:

    a. Run (YL-0210A, 0220A, 0230A)

    b. Off (YL-0210B, 0220B, 0230B)

6. Existing Raw Water Pump Station Level Indicating Transmitter (12-LIT-0110):

    a. Level (LI-0110)

M. Alarms:

1. Raw Water Flow Control Valve Vault Motorized Modulating Plug Valve:

    a. Torque (NAHH-0107)

2. Existing Raw Water Pump Station Pumps:

a. Fail (YA-0110A, 0120A, 0130A)

b. E-Stop (YA-0110B, 0120B, 0130B)

3. Existing Raw Water Pump Station Level Switches:

a. High Level (LAH-0110)

b. Low Level (LAL-0110)

N. Initial Setpoints

Initial setpoints prior to selection of others by the Operator shall be as follows:

Parameter	Initial Value	Related Setpoints and Notes
Carson Reservoir Depth D1	14-foot depth	Top of LB1, below D1 FSP_{CR} = 700 gpm
Carson Reservoir Depth D2	17-foot depth	Top of LB2, below D2 FSP_{CR} = 500 gpm
Carson Reservoir Depth D3	20-foot depth	Top of LB3, below D3 FSP_{CR} = 300 gpm, above D3 FSP_{CR} = 100 gpm
Raw Water Wet Well Depth D4	40-inch depth	Below D4, Raw Water Flow into Wet Well is full capacity
Raw Water Wet Well Depth D5	50-inch depth	This is the level setpoint to be controlled by production from the membrane container
LSH-0110	64-inch depth	At this high level RW will shut down to prevent a spill
MCS Pause	40-inch depth	
MCS Resume	46-inch depth	

3.2 **COTAINERIZED MEMBRANE FILTRATION SYSTEM (VENDOR SYSTEM)**

A. Reference Drawing: 20I-601, 25I-601

B. Equipment:

1. Containerized Membrane Filtration System (MCP-MS)

2. Pneumatic Valves (20-POV-0110, 0111, 0112)

3. Filtered Water Meter and Chemical Injection Vault

    a. Mag Flowmeter (20-FIT-0140)

    b. Leak Detection Switch (LSH-0140)

4. Pressure Gauges (PI-0153, 0156)Existing Chlorine Residual (25-AIT-0115)

5. Existing Carson Reservoir (25-TK-0120)

    a. Level Indicating Transmitter (25-LIT-0120)

    b. Level Switch High (25-LSH-0120)

6. Existing Brooks Reservoir (25-TK-0210)

    a. Level Indicating Transmitter (25-LIT-0210)

    b. Alarms (25-XS-0210)

C. Description:

1. The membrane system will monitor the level of the existing finished water Carson Reservoir Tank (25-TK-0120).

    a. The Operator will set Pause and Resume levels for the membrane system operation.

    b. The Operator will also set a flow setpoint (20-FIT-0140) for the membrane system.

    c. When the finished water Carson Reservoir tank level is high (25-LSH-0120) and at the Pause level, the membrane system will cease production and pause.

    d. When the finished water Carson Reservoir tank level drops down to the resume level, the membrane system will resume operation at the flow setpoint (20-FIT-0140).

2. The membrane system will monitor the level of Neutralized Waste in the Neutralization Tank (30-TK-0110) and CIP Waste Storage Tank (45-TK-0100).

    a. The Operator will set Pause and Resume levels for the membrane system operation.

    b. The Operator will also set a level setpoint (20-FIT-0140) for the membrane system.

    c. When the sodium hypochlorite, sodium hydroxide, or citric acid in the trailer level is high and at the Pause level, the respective chemical transfer pump will cease operation by stopping the air compressor and closing the solenoid valve.

d. When the sodium hypochlorite, sodium hydroxide, or citric acid in the trailer level drops down to the resume level, the respective chemical transfer pumps will resume operation by turning on the respective air compressor and opening the solenoid valve at the level setpoint.

3. Additional detailed strategies provided by vendor.

D. Containerized Membrane Filtration System

1. The control system will have an Enable / Disable button for the Membrane Container System. If 25-LSH-0120 in the Existing Carson Reservoir is activated, the Raw Water System will Pause. If 25-LSH-0120 is not activated, the Raw Water System will Resume.

2. If the LSL-0110 in the RW WW is active, the Membrane Container shall Pause. When LSL-0110 is inactive, the Membrane Container shall Resume.

3. The Membrane Container System (MCS) flow will be controlled to achieve a target Level Set Point, D5, in the Raw Water wet well selected by the Operator. The Operator shall select D5 to be higher than D4. The Control System will provide the flow rate reading from 10-FE-0110 as an initial estimate of the Flow Set Point required from the MCS to maintain the level set point D5 in the RW WW. If the actual depth in the WW Dactual is greater than the level set point D5, then production from the MCS shall increase to reduce Dactual. If Dactual is lower than the level set point D5, then production from the MCS shall decrease to increase Dactual.

4. The MCS shall pause production if the wet well gets low water level. The MCS shall resume production when the wet well level increases.

E. Interlocks: TBD

F. SCADA Commands: TBD

G. Existing Mission Telemetry System:

1. Chlorine Residual Analyzer (AIT-0115)

2. Carson Reservoir Level Indicating Transmitter (LIT-0120)

3. Carson Reservoir Level Switch High (LSH-0120)

4. Brooks Reservoir Level Indicating Transmitter (LIT-0210)

5. Brooks Reservoir Alarms (XA-0210)

H. Key Instruments/Signals via SCADA:

1. Filtered Water Meter and Chemical Injection Vault Flowmeter:

a. Flow (FI-0140)

2. Existing Carson Reservoir:

a. Level (LI-0120)

I. Alarms:

1. Filtered Water Meter and Chemical Injection Vault:

a. Leak (LAL-0140)

2. Existing Carson Reservoir:

a. High Level (LAH-0120)

3. Water Quality Parameters:

a. Error: High High chlorine residual

b. Error: Low Low chlorine residual

c. Error: Turbidity greater than 0.05 NTU

4. Direct Membrane Integrity Testing

a. Error: Failure of Direct Membrane Integrity Test as specified in Section 46 61 34 Containerized Membrane Filtration System.

3.3 CHLORINE CONTACT TANK

A. Reference drawing: 20I-601, 25I-601, 30I-610

B. Equipment:

1. Chlorine Contact Tank Level Switch (25-LSH-0110)

2. Chlorine Analyzer (30-AIT-1030)

3. Flow Meter (20-FE-0140)

4. pH/Temp Analyzer (30-AIT-1021)

C. Description: Based on the flow measured by the Flowmeter (20-FE-0140) and the Chlorine Residual as measured by the Chlorine Analyzer (30-AIT-1030), the Chlorine Contact Tank will establish and maintain the Chlorine Contact Time (CT) required by the State of Washington. The Chlorine Contact Time will be the time from the filtered water has entered the Chlorine Contact Tank to the discharge line that the now Chlorine Contact Time potable water will flow to the Carson Reservoir.

pH/Temp Analyzer (30-AIT-0121) will record the daily temperature and pH of the water going into the Chlorine Contact Tank on a continuous running average of 24 hours on a per hour basis.

D. Local Controls: None.

E. Local Automatic Controls: None.

F. SCADA Inputs/Manual Controls Mode: None.

G. SCADA Automatic Control Mode:

1. Chlorine Contact Time – The Filtered Water Meter and Chemical Injection Vault Flowmeter (20-FE-0140) along with the Chlorine Residual Analyzer (30-AIT-1030) shall measure the peak hour flow rate (gal/min) and Chlorine Residual (mg/l) entering the Chlorine Contact Tank. Based on the flow rate and Chlorine Residual – SCADA will calculate the required Chlorine Contact Time.

2. SCADA shall calculate $CT_{achieved}$ with the following equation:

$CT_{achieved} = (Cl)\ (T_{10})$

Where:

Cl = Chlorine Residual (mg/l)
T_{10} = Effective detention time

Where:

$$T_{10} = \frac{(e)\ (V)}{Q}$$

Where:

e = Hydraulic efficiency (assumed be 0.3)
V = Tank Volume (160,000 gal)
Q = Peak hour flow rate (gal/min)

Where:

Q = Peak hourly flow is determined by a continuous running average of 60 minutes on a per minute data recording basis

H. Interlocks: None.

I. SCADA Commands: None.

J. Key Instruments/Signals Monitored via SCADA:

1. Filtered Water Meter and Chemical Injection Vault Flowmeter:

a. Average Flow (FQI-0140)

2. Average Temperature (AQI-1021)

3. Chlorine Residual (AI-1030)

K. Alarms:

1. Chlorine Contact Tank:

a. High Level (LSH-0110)

3.4 NEUTRALIZATION SKID PUMP (VENDOR SYSTEM)

A. Reference Drawing: 30I-601

B. Equipment:

1. Neutralization Skid Pump (30-P-0120, 30-STRT-0120, 30-TSH-0120, 30-FSL-0120)

2. Pneumatic Valves (30-POV-0121, 0141, 0150, 0160, 0170, 0180)

3. Neutralization Dechlorination Off-Skid Tank (30-TK-0110, 30-LIT-0110, 30-LSHH-0110, 30-LSLL-0110)

4. Neutralization Skid Analytical Analyzer (30-AIT-0120)

C. Description:

1. The Neutralization system will monitor the level of the Neutralization / Dechlorination Off-Skid Tank (30-TK-0110).

   a. The Operator will set Pause and Resume levels for the Neutralization system operation.

   b. The Operator will also set a level setpoint for the Neutralization system as measured by (30-LIT-0110). When the Neutralization level is high as detected by (30-LSH-0110) and at the Pause level, the Neutralization system will cease recirculation and pause.

   c. When the Neutralization tank level drops down to the resume level, the Neutralization system will resume operation at the level setpoint as measured by (30-LIT-0110).

2. The Neutralization system will monitor its level of Neutralized Waste in the Neutralization / Dechlorination Off-Skid Tank and CIP Waste Storage Tank.

   a. The Operator will set Pause and Resume levels for the Neutralization system operation.

   b. The Operator will also set a level setpoint as measured by (30-LIT-0110) for the Neutralization system.

   c. When the Neutralized Waste in the Neutralization Dechlorination Off-Skid Tank level is high as detected by (30-LSH-0110) and at the Pause level, the respective chemical transfer pump will cease operation by turning off the air compressor and closing the solenoid valve.

   d. When the Neutralized Waste in the Neutralization Dechlorination Off-Skid Tank level drops down to the resume level, the respective chemical transfer pumps will resume operation by turning on the air compressor and opening the solenoid valve at the level setpoint.

3. Additional detailed strategies shall be providedby the membrane system vendor.

D. Interlocks:

1. Neutralization Skid Pump:

a. Low Flow (FAL-0120)

b. High Temp (TAH-0120)

E. SCADA Commands:

1. Neutralization Skid Pump:

a. Start Command (HS-0120A)

Stop Command (HS-0120B)

F. Key Instruments/Signals Monitored via SCADA:

1. Neutralization Skid Pump:

a. Run (YL-0120)

2. In Auto (ZL-0120)Neutralization Skid Analytical Analyzer:

a. pH/ORP (AI-0120)

3. Tank Level Transmitter (30-LIT-0110):

a. Level (LI-0110)

G. Alarms:

1. Neutralization Skid Tank:

a. High High Level (LAHH-0110)

b. Low Low Level (LALL-0110)

2. Neutralization Skid Pump:

a. Fail (YA-0120A)

b. E-Stop (YA-0120B)

3.5 **ALUMINUM CHLOROHYDRATE (ACH) FEED**

A. Reference Drawing: 30I-602

B. Equipment:

1. Aluminum Chlorohydrate Bulk Tank (30-TK-0201, LT-0201)

2. Aluminum Chloralhydrate Feed Pumps (30-P-0210, 30-P-0220, 30-P-0230), (30-PI-0210A, 0210B, 0220A, 0220B, 0230A, 0230B), (30-PSH-0210, 0220, 0230)

C. Description: The Aluminum Chlorohydrate chemical feed system is supplied by an Aluminum Chlorohydrate Bulk Tank (30-TK-0201) and pumps to the metering point via three variable speed feeder pumps (30-P-0210, 30-P-0220, and 30-P-0230). The feeder pumps are part of vendor supplied chemical feeder systems. The feeder pumps shall automatically flow pace chemical to the injection point using Flow Indicating Transmitter (10-FIT-0110) and pH/Temp Analytical Analyzer (10-AIT-0110).

D. Local Controls: Local control for each of the chemical feeder pumps is performed by placing the individual pump LOCAL/OFF/REMOTE selector switch to the LOCAL mode to START/STOP the feeder pump and into the OFF mode to STOP the pump. The speed of the feeder pump will be made by adjusting the local potentiometer.

E. Local Automatic Control Mode: There are no local automatic controls for the ACH feeder pumps.

F. SCADA Inputs/Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The chemical feeder pumps shall have a Local Control Panel.

a. When the LOCAL/OFF/REMOTE switch for each pump at the LCP is in REMOTE mode, the SCADA system receives an IN REMOTE status input from the LCP for indication at SCADA HMI. A pump RUN status input for indication at SCADA HMI, a pump FAIL alarm input and analog speed value is also received for indication at SCADA HMI.

b. The pump speed can be remotely adjusted from SCADA HMI with the AUTO/MANUAL selector switch at the HMI in the MANUAL mode and entering a speed value at the speed control field with a 0-100% speed setting. It can also be STARTED/STOPPED remotely from SCADA HMI with the AUTO/MANUAL selector switch at the HMI in the MANUAL mode.

2. Each feeder pump has a RUN status input for indication, a pump FAIL alarm input, and an analog speed value is also received for indication at the SCADA HMI.

3. The Aluminum Chlorohydrate Bulk Tank has a LEVEL status input for monitoring at the SCADA HMI.

G. SCADA Automatic Control Mode: All Aluminum Chlorohydrate feeder pumps shall be controlled to maintain an operator selected dosage rate for the feed point at the Raw Water Vault.

1. Dosage control – Feeder pumps shall be flow paced to the Raw Water flowmeter (10-FIT-0110) to provide the operator selected dosage in mg/L. Based on the selected dosage, pump characteristics, and pacing signal, the PLC will calculate the required pump speed to provide the selected dosage. The relationship for determining pump speed is shown below. All variables in this equation will be adjustable from the HMI.

2. The pump pacing signal is determined in accordance with the following equation:

$$Sd = \frac{(D)\ (Q)\ (8.34)}{(St)\ (Q100)\ (C)\ (24)}$$

Where:

Sd	=	Pump speed pacing signal in percent of maximum.
D	=	Chemical feed dosage in mg/l. Operator input.
Q	=	Pacing flow rate in mgd. Signal from the flow meter.
St	=	Pump stroke in percent of maximum. Operator input.
Q100	=	Pump output in gal/hr. at 100% stroke and 100% speed. Operator input.
C	=	Chemical concentration in lb./gal. Operator input.
24	=	Constant (no. of hrs./day)
8.34	=	Constant

H. Interlocks:

1. Aluminum Chlorohydrate Feed Pumps:

    a. Pressure High (PAH-0210, 0220, 0230)

2. Aluminum Chlorohydrate Bulk Tank:

    a. Level Low Low (LAH-0201)

I. SCADA Commands:

1. Aluminum Chlorohydrate Feed Pumps:

    a. Start Command (HS-0210A, 0220A, 0230A)

    b. Stop Command (HS-0210B, 0220B, 0230B)

    c. Speed Setpoint (SC-0210, 0220, 0230)

J. Key Instruments/Signals Monitored via SCADA:

1. ACH Bulk Tank:

    a. Level (LI-0201)

2. Aluminum Chlorohydrate Feed Pumps:

    a. Run (YL-0210, 0220, 0230)

    b. In Remote (ZL-0210, 0220, 0230)

    c. Speed (SI-0210, 0220, 0230)

K. Alarms:

1. ACH Bulk Tank:

a. Leak (LALL-0201)

2. Aluminum Chlorohydrate Feed Pumps:

a. Fail (YA-0210, 0220, 0230)

3.6 SODIUM HYPOCHLORITE (SHC) FEED

A. Reference Drawing: 30I-603, 30I-604

B. Equipment:

1. Blower (30-BL-0340, 30-MS-0340, 30-FSL-0340, 30-TSH-0340)

2. Sodium Hypochlorite Storage Tank (30-TK-0350, 30-LIT-0350, 30-LSH-0350, 30-FSL-0350)

3. Sodium Hypochlorite Feed Pumps (30-P-0410 and 30-P-0420), (30-PI-0410 and 0420), (30-PSH-0410 and 0420)

4. Sodium Hypochlorite Transfer Pump (30-P-0430), (30-PSH-0430)

5. Mag Flowmeter (30-FIT-0430)

C. Description: The SHC chemical feed system is supplied by a Sodium Hypochlorite Tank (30-TK-0350), and pumps to the feeder point via two variable speed feeder pumps (30-P-0410, 30-P-0420). The feeder pumps are part of vendor supplied chemical feeder systems. The feeder pumps shall automatically flow pace chemical to the injection point using Flow Indicating Transmitter (10-FIT-0110) for the Raw Water Vault and Flow Indicating Transmitter (20-FIT-0140) for the Filtered Water Chemical Meter Vault.

D. Local Controls: Local control for each of the chemical feeder pumps is performed by placing the individual pump LOCAL/OFF/REMOTE selector switch to the LOCAL mode to start/stop the feeder pump and into the OFF mode to stop the pump. The speed of the feeder pump will be made by adjusting the local potentiometer.

E. Local Automatic Control Mode: There are no local automatic controls for the Sodium Hypochlorite feeder and transfer pumps.

F. SCADA Inputs/Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The chemical feeder pumps shall have a Local Control Panel.

a. When the LOCAL/OFF/REMOTE switch for each pump at the LCP is in REMOTE mode, the SCADA system receives an IN REMOTE status input from the LCP for indication at SCADA HMI. A pump RUN status input for indication at SCADA HMI, a pump FAIL alarm input and analog speed value is also received for indication at SCADA HMI.

b. The pump speed can be remotely adjusted from SCADA HMI with the AUTO/MANUAL selector switch at the HMI in the MANUAL mode and entering a speed value at the speed control field with a 0-100% speed setting. It can

also be STARTED/STOPPED remotely from SCADA HMI with the AUTO/MANUAL selector switch at the HMI in the MANUAL mode

2. Each feeder pump has a RUN status input for indication, a pump FAIL alarm input, and an analog speed value is also received for indication at the SCADA HMI.

3. The Sodium Hypochlorite Tank has a LEVEL status input for monitoring at the SCADA HMI.

G. The transfer pump discharge has a FLOW status input for monitoring at the SCADA HMI.SCADA Automatic Control Mode: All Sodium Hypochlorite feeder pumps shall be controlled to maintain an operator selected dosage rate for the feed point at the Raw Water Vault and static mixer in the Filtered Water Chemical Meter Vault.

1. Dosage control – Feeder pumps shall be flow paced to the Raw Water Flowmeter (10-FIT-0110) and Finished Water Flowmeter (20-FIT-0140) to provide the operator selected dosage in mg/L. Based on the selected dosage, pump characteristics, and pacing signal, the PLC will calculate the required pump speed to provide the selected dosage. The relationship for determining pump speed is shown below. All variables in this equation will be adjustable from the HMI.

2. The pump pacing signal is determined in accordance with the following equation:

$$Sd = \frac{(D)\,(Q)\,(8.34)}{(St)\,(Q100)\,(C)\,(24)}$$

Where:

Sd	=	Pump speed pacing signal in percent of maximum.
D	=	Chemical feed dosage in mg/l. Operator input.
Q	=	Pacing flow rate in mgd. Signal from the flow meter.
St	=	Pump stroke in percent of maximum. Operator input.
Q100	=	Pump output in gal/hr. at 100% stroke and 100% speed. Operator input.
C	=	Chemical concentration in lb./gal. Operator input.
24	=	Constant (no. of hrs./day)
8.34	=	Constant

H. Interlocks:

1. Sodium Hypochlorite Feed and Transfer Pumps:

a. Pressure High (PAH-0410, 0420, 0430)

2. Sodium Hypochlorite Storage Tank:

a. Leak (LALL-0350)

I. SCADA Commands:

1. Sodium Hypochlorite Feed Pumps:

a. Start Command (HS-0410A and 0420B)

b. Stop Command (HS-0410A and 0420B)

c. Speed Setpoint (SC-0410 and 0420)

J. Key Instruments/Signals Monitored via SCADA:

1. Sodium Hypochlorite Tank:

a. Level (LI-0350)

2. Sodium Hypochlorite Feed Pumps:

a. Run (YL-0410 and 0420)

b. In Remote (ZL-0410 and 0420)

c. Speed (SI-0410 and 0420)

3. Sodium Hypochlorite Transfer Pump Mag Flowmeter:

a. Flow (FI-0430)

K. Alarms:

1. Sodium Hypochlorite Tank:

a. Leak (LAL-0350)

2. Sodium Hypochlorite Feed Pumps:

a. Fault (YA-0410 and 0420)

3.7 SODIUM HYDROXIDE (SDH) FEED

A. Reference Drawing: 30I-605

B. Equipment:

1. Sodium Hydroxide Bulk Tank (30-TK-0501, 30-LT/LI-0501)

2. Sodium Hydroxide Feed Pumps (30-P-0510 and 30-P-0520), (30-PI-0510 and 0520) (30-PSH-0510 and 0520)

3. Sodium Hydroxide Transfer Pumps (30-P-0530 and 30-P-0540), (30-PSH-0530 and 0540)

4. Mag Flowmeters (30-FIT-0530 and 0540)

5. Eyewash (30-EWS-0501, 30-FSH-0501)

C. Description: The Sodium Hydroxide chemical feed system is supplied by a Sodium Hydroxide bulk tank (30-TK-0501), and pumps to the feeder point via two variable speed feeder pumps (30-P-0510, 30-P-0520). The feeder pumps are part of vendor supplied chemical feeder systems. The feeder pumps shall automatically flow pace chemical to

the injection point using Flow Indicating Transmitter (10-FIT-0110) for Raw Water Vault and Flow Indicating Transmitter (20-FIT-0140) for Filtered Water Chemical Meter Vault.

D. Local Controls: Local control for each of the chemical feeder pumps is performed by placing the individual pump LOCAL/OFF/REMOTE selector switch to the LOCAL mode to start/stop the feeder pump and into the OFF mode to stop the pump. The speed of the feeder pump will be made by adjusting the local potentiometer.

E. Local Automatic Control Mode: There are no local automatic controls for the Sodium Hydroxide feeder pumps.

F. SCADA Inputs/Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The chemical feeder pumps shall have a Local Control Panel.

   a. When the LOCAL/OFF/REMOTE switch for each pump at the LCP is in REMOTE mode, the SCADA system receives an IN REMOTE status input from the LCP for indication at SCADA HMI. A pump RUN status input for indication at SCADA HMI, a pump FAIL alarm input and analog speed value is also received for indication at SCADA HMI.

   b. The pump speed can be remotely adjusted from SCADA HMI with the AUTO/MANUAL selector switch at the HMI in the MANUAL mode and entering a speed value at the speed control field with a 0-100% speed setting. It can also be STARTED/STOPPED remotely from SCADA HMI with the AUTO/MANUAL selector switch at the HMI in the MANUAL mode.

2. Each feeder pump has a RUN status input for indication, a pump FAIL alarm input, and an analog speed value is also received for indication at the SCADA HMI.

G. The Sodium Hydroxide Bulk Tank has a LEVEL status input for monitoring at the SCADA HMI.SCADA Automatic Control Mode: All Sodium Hydroxide feeder pumps shall be controlled to maintain an operator selected dosage rate for the feed point at the Raw Water Vault and static mixer in the Filtered Water Chemical Meter Vault.

1. Dosage control – Feeder pumps shall be flow paced to the Raw Water Flowmeter (10-FIT-0110) and Finished Water Flowmeter (20-FIT-0140) to provide the operator selected dosage in mg/L. Based on the selected dosage, pump characteristics, and pacing signal, the PLC will calculate the required pump speed to provide the selected dosage. The relationship for determining pump speed is shown below. All variables in this equation will be adjustable from the HMI.

2. The pump pacing signal is determined in accordance with the following equation:

$$Sd = \frac{(D)\,(Q)\,(8.34)}{(St)\,(Q100)\,(C)\,(24)}$$

Where:

Sd = Pump speed pacing signal in percent of maximum.
D = Chemical feed dosage in mg/l. Operator input.
Q = Pacing flow rate in mgd. Signal from the flow meter.

St	=	Pump stroke in percent of maximum. Operator input.
Q100	=	Pump output in gal/hr. at 100% stroke and 100% speed. Operator input.
C	=	Chemical concentration in lb./gal. Operator input.
24	=	Constant (no. of hrs./day)
8.34	=	Constant

H. Interlocks:

1. Sodium Hydroxide Bulk Tank:

    a. Level Low Low (LALL-0501)

2. Sodium Hydroxide Feed and Transfer Pumps:

    a. Pressure High (PAH-0510, 0520, 0530, 0540)

I. SCADA Commands:

1. Sodium Hydroxide Feed Pumps:

    a. Start Command (HS-0510A and 0520A)

    b. Stop Command (HS-0510B and 0520B)

    c. Speed Setpoint (SC-0510 and 0520)

J. Key Instruments/Signals Monitored via SCADA:

1. Sodium Hydroxide Bulk Tank:

    a. Level (LI-0501)

2. Sodium Hydroxide Feed Pumps:

    a. Run (YL-0510 and 0520)

    b. In Auto (ZL-0510 and 0520)

    c. Speed (SI-0510 and 0520)

3. Sodium Hydroxide Transfer Pump Mag Flowmeter:

    a. Flow (FIT-0530 and 0540)

    b. Alarms:

4. Sodium Hydroxide Feed Pumps:

    a. Fail (YA-0510 and 0520)

5. Eyewash Station:

    a. Flow On (FAH-0501)

3.8 CITRIC ACID TRANSFER

A. Reference Drawing: 30I-606

B. Equipment:

1. Citric Acid Tote (30-TK-0601, 30-WIT-0601)

2. Pneumatic Transfer Pumps (30-P-0610, 30-P-0620), (30-PSH-0610 and 0620), 30-FIT-610 and 0620)

3. Mag Flowmeter (30-FIT-0610)

C. Description: Additional detailed strategies provided by vendor.

D. SCADA Inputs/Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The Citric Acid Tote has a WEIGHT status input for monitoring at the SCADA HMI.

E. Interlocks:

1. Citric Acid Transfer Pumps:

a. Pressure High (PAH-0610 and 0620)

F. SCADA Commands: TBD

G. Key Instruments/Signals Monitored via SCADA:

1. Citric Acid Tote:

a. Weight (WI-0601)

2. Citric Acid Transfer Pumps Mag Flowmeter:

a. Flow (FIT-0610 and 0620)

H. Alarms:

1. Eyewash Station:

a. Flow High (FAH-0602)

3.9 CALCIUM THIOSULFATE FEED

A. Reference Drawing: 30I-607

B. Equipment:

1. Pneumatic Transfer Pump (30-P-0710, 30-PSH-0710, 30-FIT-0710)

2. Mag Flowmeter (30-FIT-0710)

C. Description: Additional detailed strategies provided by vendor.

D. SCADA Inputs/Manual Control Mode: None.

E. Interlocks:

1. Citric Acid Transfer Pumps:

a. Pressure High (PAH-0720)

F. SCADA Commands:

G. Key Instruments/Signals Monitored via SCADA:

1. Calcium Thiosulfate Transfer Pump Mag Flowmeter:

a. Flow (FIT-0710)

H. Alarms: None.

3.10 BRINE FEED (VENDOR SYSTEM)

A. Reference Drawing: 30I-603, 30I-608

B. Equipment:

1. Pressure Transmitter (30-PIT-0320)

2. Brine Storage Tank (30-TK-0310, 30-LE/LIT-0310, 30-SOV-0333)

3. OSHG Vendor Control Panels (30-VCP-0810 and 30-VCP-0820)

4. Brine Pumps (30-P-0810 and 30-P-0820), (30-LCP-0810 and 30-LCP-0820), 30-SOV-0814 and 0824, 30-FCV-0815 and 0825)

5. Electrolyzer Cells (30-ME-0811 and 30-ME-0821)

6. Level Switches (30-LSL-0810 and 0820)

7. Temperature Transmitters (30-TT-0810 and 0820)

8. H2 Analytical Analyzer (30-AIT-0830)

C. Description: The On-Site Hypochlorite Generation (OSHG) system will monitor the level of the sodium hypochlorite water SHC Tank (30-TK-0350).

1. The Operator will set Pause and Resume levels for the OSHG system operation.

2. The Operator will also set a level setpoint for the OSHG system.

3. When the sodium hypochlorite water SHC tank level is high and at the Pause level, the OSHG system will cease production and pause.

4. When the sodium hypochlorite water SHC tank level drops down to the resume level, the OSHG system will resume operation at the level set point (30-LIT-0350).

D. Additional detailed strategies provided by vendor.

E. SCADA Inputs /Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The Brine Storage Tank has a LEVEL status input for monitoring at SCADA HMI.

2. The water softener vendor package discharge has a PRESSURE status input for indication at the SCADA HMI.

F. Interlocks: None.

G. SCADA Commands:

1. Vendor Control Panels:

a. Remote Enable Command (HS-0810A and 0820A)

b. E-Stop Command (HS-0810B and 0820B)

2. H2 Analytical Analyzer:

a. Silence (HS-0830A and 0830C)

b. Turn Off (HS-0830B and 0830D)

H. Key Instruments/Signals Monitored via SCADA:

1. Vendor Control Panels:

a. System Ready Status (YL-0810A and 0820A)

b. Prep On Status (YL-0810B and 0820B)

c. Dosing Enable Status (YL-0810C and 0820C)

d. Volts (EI-0811 and 0821)

e. Amps (II-0811 and 0821)

2. H2 Analytical Analyzer:

a. H2 (AI-0830)

I. Alarms:

1. Vendor Control Panels:

a. Error (YA-0810A and 0820A)

b. Stop Active (YA-0810B and 0820B)

2. H2 Analytical Analyzer:

    a. H2 High (AAH-0830)

3.11 PNEUMATIC AIR VALVES HANDLING

A. Reference Drawing: 30I-611

B. Equipment:

1. Off-Trailer Caustic/Neut/Circ System Valves (RIO-0120)

2. Off-Trailer Acid and Calcium Thiosulfate System Valve Area (RIO-0600)

C. Description: The Off-Trailer Caustic/Neut/Circ System and Off-Trailer Acid and Calcium Thiosulfate System Valves will control the solenoid banks that will send pressurized air that will open/close and turn on the transfer pumps.

D. Local Controls: There are no local controls for the solenoid valves bank.

E. Local Automatic Control Mode: There are no local automatic controls for the solenoid valves bank.

F. SCADA Inputs/Manual Control Mode: The following SCADA inputs and control shall be furnished:

1. Pneumatic Valves:

    a. Each of the solenoid valves has an OPEN and CLOSED status input for monitoring at SCADA HMI.

    b. Each of the solenoid valves has an OPEN/CLOSE command to open or close the valve.

G. Interlocks: None.

H. SCADA Commands:

1. Valves:

    a. Open Command (HS-0121, 0141, 0150, 0160, 0170, 0180)

2. Transfer Pumps:

    a. On Command (HS-0120, 0430, 0530, 0540, 0610, 0620, 0710)

I. Key Instruments/Signals Monitored via SCADA: None.

J. Alarms: None.

3.12 SOLIDS HANDLING BASIN

A. Reference Drawing: 43I-601

B. Equipment:

1. Decant Pumps (43-P-0110 and 43-P-0120), (43-TSH-0110, 0120), (43-XS-0110, 0120)

2. Float Level Switches (43-LSH-0110, 43-LSH-0111, 43-LSL-0110, 43-LSH-0105)

C. Description: The Decant Pumps in the Decant Pump Station pumps to the Raw Water Pump Station as per the level in the Raw Water Pump Station.

D. Local Controls: Local control for each of the decant pumps is performed by placing the individual pump LOCAL/OFF/REMOTE selector switch to the LOCAL mode to START/STOP the decant pump and into the OFF mode to STOP the pump.

E. Local Automatic Control Mode: There are no local automatic controls for the decant pumps.

F. SCADA Inputs/Manual Control Mode: The following SCADA inputs and controls shall be furnished:

1. The decant pumps shall have the Local Control Panel:

a. When the LOCAL/OFF/REMOTE switch for each pump at the LCP is in REMOTE, the SCADA system receives an IN REMOTE status input from the LCP for the indication at SCADA HMI. A pump RUN status input for indication at SCADA HMI, a pump FAIL Alarm input is received for indication at SCADA HMI.

b. The pump can be STARTED/STOPPED remotely from SCADA HMI with the AUTO/MANAUL selector switch at the HMI in the MANUAL mode.

2. The Decant Pump Station has LEVEL HIGH, LEVEL LOW, LEVEL LOW LOW alarms that are monitored at the SCADA HMI.

G. SCADA Automatic Control Mode: Both Decant pumps shall be controlled to maintain an operator's selected flow rate (43-FIT-0150) for return to the Raw Water Pump Station.

H. Interlocks:

1. Decant Pump Station:

a. Level High (LAH-0110)

b. Level Low (LAL-0110)

c. Level Low Low (LALL-0110)

2. Decant Pumps:

a. Temperature High (TAH-0110 and 0120)

b. Leak Detection (YA-0110 and 0120)

I. SCADA Commands:

1. Decant Pumps:

a. Start Command (HS-0110 and 0120)

b. Stop Command (HS-0110 and 0120)

J. Key Instruments/Signals Monitored via SCADA:

1. Decant Pumps:

a. Run (YL-0110 and 0120)

K. Alarms:

1. Decant Pumps:

a. Fail (YA-0110 and 0120)

2. Manhole Structure

a. Level High (LAH-0110)

3.13 GENERATOR, FIRE ALARM SYSTEM

A. Reference Drawing: 43I-602

B. Equipment:

1. Generator (43-GEN-0210, 43-LCP-0210)

2. Automatic Transfer Switch (43-ATS-0210)

3. Fire Alarm System (43-FACP-0210, 43-YS-0210A/B)

C. Description: Additional detailed strategies provided by vendor.

D. Local Controls: None.

E. Local Automatic Control Mode: None.

F. SCADA Inputs/Manual Control Mode: Additional detailed strategies provided by vendor.

G. SCADA Automatic Control Mode: Additional detailed strategies provided by vendor.

H. Interlocks: None.

I. SCADA Commands: None.

J. Key Instruments/Signals Monitored via SCADA:

1. Automatic Transfer Switch:

a. Run (YL-0220)

b. Total Run (KQI-0220)

K. Alarms:

1. Generator:

a. General Alarm (YA-0210A)

b. Fuel Tank Critically Low (LALL-0210)

c. Leak (LAH-0210)

2. Automatic Transfer Switch:

a. ATS Fault (UA-0220)

b. ATS On Normal Power (YA-0220A)

c. ATS Generator Power (JA-0220)

3. Fire Alarm Panel:

a. Smoke Detected (YA-0210A)

b. Fire Alarm System Trouble (YA-0210B)

3.14 CIP WASTE STORAGE TANK

A. Reference Drawing: 45I-601

B. Equipment:

1. CIP Waste Storage Tank Pump No 1 (45-P-0110)

2. CIP Waste Storage Tank Pump No 2 (45-P-0120)

3. Float Level Switches (45-LSHH-0110, 45-LSH-0110, 45-LSL-0110, 45-LSLL-0110)

4. CIP Waste Storage Tank (45-TNK-0100, 45-VCP-0100)

C. Description: Only allowed to pump a certain volume of CIP waste to the septic tank each day, the volume to be spaced out over 24 hours. Additional detailed strategies provided by vendor.

D. Local Controls: None.

E. Local Automatic Control Mode: None.

F. SCADA Inputs/Manual Control Mode: Additional detailed strategies provided by vendor.

SCADA Automatic Control Mode: Volume of CIP waste to the septic tank is limited and spaced out daily as per adjustable setpoint.

Operators can input a daily ‘to-be-pumped’ flow volume, and then that flow gets pumped every 4 hours (six times per day, adjustable) until the input setpoint volume is reached or a low level alarm (LSLL-0110). The PLC shall divide the volume of flow (gallons) by 6 to determine how many gallons should be pumped for each cycle. For example, if we are allowed to pump around 210 gallons (operator input) per day to septic, then we will pump 35 gallons every 6 hours until we get to 210 total gallons.

G. Interlocks: None.

H. SCADA Commands:

1. Waste Storage Tank Pumps:

a. Start Command (HS-0110A and 0110A)

b. Stop Command (HS-0110B and 0120B)

I. Statuses:

1. Waste Storage Tank Pumps:

J. Alarms:

1. Waste Storage Tank Pumps:

a. Fail (YA-0110 and 0120)

2. Waste Storage Tank:

a. Level High High (LAHH-0110)

b. Level High (LAH-0110)

c. Level Low (LAL-0110)

d. Level Low Low (LALL-0110)

3.15 **SEPTIC TANK**

A. Reference Drawing: 45I-602

B. Equipment:

1. Sump Pump (45-P-0210)

2. Float Level Switches (45-LSL-0210, 45-LSH-0210, 45-LSHH-0210)

C. Description: Sump Pump will run when Float Switch Level High detects a high level in the Septic Tank No 2. Sump Pump will stop running when Float Switch Level Low does not detect any level in the Septic Tank No. 2. If Float Switch Level High High detects a high high level in the Septic Tank No. 2 it will send an alarm to the operator.

D. Local Controls: The Hand Manual Switch START will start running the sump pump. The Hand Manual Switch STOP will stop running the sump pump. The Hand Switch HOA will enable the pump to run either in Hand, Off, or Automatic. The Hand Manual Switch E-STOP will stop the sump pump running in case of emergency.

E. Local Automatic Control Mode: Sump Pump will be controlled by the float switches. If the high high level float switch detects a level, then it will send an alarm to the HMI. If the high level float switch detects a level, then it will turn on the sump pump. If the low level float switch detects a level, then it will turn off the sump pump.

F. SCADA Inputs/Manual Control Mode: None.

G. SCADA Automatic Control Mode: None.

H. Interlocks:

1. Sump Pump:

a. Temperature High (TAH-0210)

b. Level Low (LAL-0210)

c. Level High (LAH-0210)

d. Level High High (LAHH-0210)

I. SCADA Commands: None.

J. Statuses:

1. Sump Pump:

a. Runtime (KQI-0210)

b. Run (YL-0210)

K. Alarms:

1. Sump Pump:

a. Fail (YA-0210A)

b. E-Stop (YA-0210B)

3.16 **SAMPLE PUMPS AND SAMPLE PANEL**

A. Reference Drawing: 10I-601, 30I-610, 42I-601

B. Equipment:

1. Sample Pumps (10-P-0120, 42-P-0140)

2. Flow Switches (FSL-1010, 1020, 1030, 1040)

3. Analytical Analyzers (AIT-1010, 1011, 1020, 1021, 1030, 1031, 1040)

C. Description: The sample pumps are started manually. The sample pumps (10-P-0120, 42-P-0140) will pump samples to the Chemical Building Lab.

D. Local Controls: Local control for each sample pump is performed by placing the ON/OFF selector switch near the sample pump to the ON mode to start the pump and into the OFF mode to stop the pump.

E. Local Automatic Control Mode: There are no local automatic controls for the sample pumps.

F. SCADA Inputs/Manual Control Mode: There is no SCADA control of the sample pump. A sample pump RUN status input for status indication and run time accumulation at the operator workstation, and the sample pump FAIL alarm input is also received by the SCADA system.

G. SCADA Automatic Control Mode: There are no SCADA automatic controls for the sample pumps.

H. Interlocks:

1. Flow Switches:

a. Flow (FAL-1010, 1020, 1030, 1040)

I. SCADA Commands: None.

J. Statuses:

1. Analytical Analyzers:

a. Turbidity (AI-1010 and 1040)

b. pH (AI-011A, 0121A, 0131A)

c. Temperature (AI-1011B, 1021B, 1031B)

d. Average Temperature (AQI-0121)

e. Chlorine (AI-1020 and 1030)

K. Alarms:

1. Analytical Analyzers:

a. Turbidity High (AAH-1010)

b.

3.17 **EMERGENCY PLANT SHUTDOWN PROCEDURE**

A. Equipment:

1. Motorized Modulating Plug Valve (10-MOV-0107)

2. Raw Water Pump Station Pumps

3. Containerized Membrane Filtration System (MCP-MS)

4. Pneumatic Valves (20-POV-0110, 0111, 0112, 30-POV-0121, 0141, 0150, 0160, 0170, 0180, 0437, 0537, 0715, 0725)

5. Neutralization Skid Pump (30-P-0120)

6. Aluminum Chlorohydrate Feed Pumps (30-P-0210, 0220, 0230)

7. Blower (30-BL-0340)

8. Sodium Hypochlorite Feed Pumps (30-P-0140 and 0420)

9. Sodium Hydroxide (30-P-0510 and 0520)

10. Brine Pumps (30-P-0810 and 0820), (30-SOV-0814, 30-FCV-0815)

B. Description: If PLC-0100 BOP PLC received a structural integrity fail alarm then the Water Treatment Plant being the Plant Shut-down procedure to prevent any additional failures or damages to other equipment. The Containerized Membrane Filtration System will be shut-down all equipment within the trailer. Afterwards, all of the pneumatic valves that control each of the transfer pumps will close in, which will stop the transfer pumps from working. Finally, all of the feed pumps will receive a stop command that will stop all feed pumps from working. The BOP PLC will show a Plant Shutdown Failure alarm on the HMI and send an alarm to all relevant people that the Water Treatment Plant has performed an emergency shutdown to prevent further damage to equipment.

If all the feed pumps of a single chemical send a failure alarm, then this will cause the Containerized Membrane Filtration System to being the shut-down procedure and shutting down other equipment in the order as specified above. In addition, to showing a Plant Shutdown Failure alarm on the HMI and send an alarm to all relevant people that the Water Treatment Plant has performed an emergency shutdown to prevent further damage to equipment. The PLC will also send an alarm of which chemical group of feed pumps have failed.

C. SCADA Commands:

1. Shut-off Conditions:0420

   a. The Containerized Membrane Filtration System sends an Integrity Failure Alarm to the BOP PLC that will being shutting down the Containerized Membrane Filtration System and then the pneumatic valves for the transfer pumps, and finally the chemical feed pumps.

   b. If the BOP PLC receives failure alarms from all of feed pumps from one chemical:

      Aluminum Chlorohydrate (30-P-0210, 0220, 0230) (YA-0210, 0220, 0230)

      Sodium Hypochlorite (30-P-0410 and 0420) (YA-0410 and)

Sodium Hydroxide (30-P-0510 and 0520) (YA-0510 and 0520)

OSHG (30-OSHG-0810 and 0820)

Then the BOP PLC will be shutting down the Containerized Membrane Filtration System and then the pneumatic valves for the transfer pumps, and finally the remaining chemical feed pumps.

END OF SECTION

Instrument Tag	Drawing Number	Description	Install Detail Spec Ref	Ref	Measuring Principle	PLC/RIO Panel Ref	Pipe Ref
FIT/FE-0110	10I-601	Existing Raw Water Vault Intake Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
PI-0106	10I-601	Existing Raw Water Vault Coagulant Feed System Pressure Gauge	40 73 00	I-301	Elastic deformation		
PI-0107	10I-601	Existing Raw Water Vault Sodium Hydroxide Feed System Pressure Gauge	40 73 00	I-301	Elastic deformation		
PI-0108	10I-601	Existing Raw Water Vault Sodiuym Hypochlorite Feed System Pressure Gauge	40 73 00	I-301	Elastic deformation		
FI-0120	10I-601	Existing Raw Water Vault Sample Pump Roatameter	40 71 00	I-106	Spring Resistance		
LSH/L-0110	12I-601	Raw Water Pump Station Level Switch High/Low	40 72 76	I-151	Buoyancy	PLC-1000 BOP PLC	
LIT-0110	12I-601	Raw Water Pump Station Level Indicating Transmitter	40 72 00	I-202	Radar	PLC-1000 BOP PLC	
FIT/FE-0140	20I-601	Filtered Water Meter and Chemical Injection Vault Intake Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
PI-0153	20I-601	Filtered Water Meter and Chemical Injection Vault Sodium Hydroxide Feed System Pressure Gauge	40 73 00	I-301	Elastic deformation		
PI-0156	20I-601	Filtered Water Meter and Chemical Injection Vault Sodium Hypochlorite Feed System Pressure Gauge	40 73 00	I-301	Elastic deformation		
LSL-0140	20I-601	Filtered Water Meter and Chemical Injection Vault Leak Detection Switch	40 72 76	I-253	Vibration	PLC-1000 BOP PLC	
LSH-0110	25I-601	Chlorine Contact Tank Level Switch High	40 72 76	I-253	Vibration	PLC-1000 BOP PLC	
LIT-0110	30I-601	Neutralization Dechlorination Off-Skid Tank Level Indicating Transmitter	40 72 00	I-205	Differential Pressure	MCP-MS	
LSHH/LL-0110	30I-601	Neutralization Dechlorination Off-Skid Tank Level Switch High High/Low Low	40 72 76	I-253	Vibration	MCP-MS	
FSL-0120	30I-601	Neutralization Skid Pump Intake Flow Switch Low	40 71 79	I-152	Heat Transfer	MCP-MS	
TSH-0120	30I-601	Neutralization Skid Pump Temperature Switch High				MCP-MS	
PI-0120	30I-601	Neutralization Skid Pump Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation	MCP-MS	
AE/AIT-1010/1020A/B	30I-601	Neutralization Skid Pump Discharge ORP/pH Analytical Indicating Analyzer	40 75 00			MCP-MS	
LT/LI-0201	30I-602	Aluminum Chlorohydrate Bulk Tank Level Transmitter	40 72 00	I-202	Radar	PLC-1000 BOP PLC	
PI-0210	30I-602	Aluminum Chlorohydrate Feed Pump No. 1 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0210	30I-602	Aluminum Chlorohydrate Feed Pump No. 1 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PI-0220	30I-602	Aluminum Chlorohydrate Feed Pump No. 2 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0220	30I-602	Aluminum Chlorohydrate Feed Pump No. 2 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PI-0230	30I-602	Aluminum Chlorohydrate Feed Pump No. 3 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0230	30I-602	Aluminum Chlorohydrate Feed Pump No. 3 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PIT-0320	30I-603	Water Softener Vendor Package Discharge Pressure Indicating Transmitter	40 73 00	I-302	Elastic deformation	PLC-1000 BOP PLC	
PI-0320	30I-603	Water Softener Vendor Package Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PI-0327	30I-603	Filtered Water Pumps Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
TSH-0340	30I-603	Dilution Blower Temperature Switch High				30-VCP-0800	
FSL-0340	30I-603	Dilution Blower Discharge Flow Switch Low	40 71 79	I-152	Heat Transfer	30-VCP-0800	
LIT-0350	30I-603	Sodium Hypochlorite Storage Tank Pressure Differential Level Indicating Transmitter	40 72 00	I-205	Differential Pressure	30-VCP-0800	
LSL-0350	30I-603	Sodium Hypochlorite Storage Tank Leak Detection Switch	40 72 76	I-253	Vibration	30-VCP-0800	
FSL-0350	30I-603	Sodium Hypochlorite Storage Tank Flow Switch Low	40 71 79	I-152	Heat Transfer	30-VCP-0800	
PI-0410	30I-604	Sodium Hypochlorite Feed Pump No. 1 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0410	30I-604	Sodium Hypochlorite Feed Pump No. 1 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PI-0420	30I-604	Sodium Hypochlorite Feed Pump No. 2 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0420	30I-604	Sodium Hypochlorite Feed Pump No. 2 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PSH-0430	30I-604	Sodium Hypochlorite Transfer Pump Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FE/FIT-0430	30I-604	Sodium Hypochlorite Transfer Pump Discharge Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
FSH-0501	30I-605	Hypo-Caustic Room Emergency Eyewash Station Flow Switch Low	40 71 79	I-152	Heat Transfer	PLC-1000 BOP PLC	
LT/LI-0501	30I-605	Sodium Hypoxide Bulk Tank Level Transmitter	40 72 00	I-202	Radar	PLC-1000 BOP PLC	
PI-0510	30I-605	Sodium Hydroxide Feed Pump No. 1 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0510	30I-605	Sodium Hydroxide Feed Pump No. 1 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PI-0520	30I-605	Sodium Hydroxide Feed Pump No. 2 Discharge Pressure Gauge	40 73 00	I-301	Elastic deformation		
PSH-0520	30I-605	Sodium Hydroxide Feed Pump No. 2 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
PSH-0530	30I-605	Sodium Hydroxide Transfer Pump No. 1 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FE/FIT-0530	30I-605	Sodium Hydroxide Transfer Pump No. 1 Discharge Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
PSH-0540	30I-605	Sodium Hydroxide Transfer Pump No. 2 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FE/FIT-0540	30I-605	Sodium Hydroxide Transfer Pump No. 2 Discharge Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
FSH-0602	30I-606	Chloro-Thio Room Emergency Eyewash Station Flow Switch Low	40 73 36	I-152	Heat Transfer	PLC-1000 BOP PLC	
WE/WIT-0601	30I-606	Citric Acid (50%) Tote Weight Indicating Transmitter	43 30 00	I-802	Weight	PLC-1000 BOP PLC	
PSH-0610	30I-606	Citric Acid Transfer Pump No. 1 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FE/FIT-0610	30I-606	Citric Acid Transfer Pump No. 1 Discharge Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
PSH-0620	30I-606	Citric Acid Transfer Pump No. 2 Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FE/FIT-0620	30I-606	Citric Acid Transfer Pump No. 2 Discharge Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
PSH-0710	30I-607	Calcium Thiosulfate Transfer Pump Discharge Pressure Switch High	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FE/FIT-0710	30I-607	Calcium Thiosulfate Transfer Pump Discharge Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
AE/AIT-0830	30I-608	OSHG Hydrogen Gas Analytical Indicating Transmitter	40 75 00	I-601		30-VCP-0800	
PI-0810	30I-608	OSHG Unit 1 Pressure Gauge	40 73 00	I-301	Elastic deformation	30-VCP-0800	
FI-0810	30I-608	OSHG Unit 1 Orfice Flowmeter	40 71 00			30-VCP-0800	
LSL/TT-0810	30I-608	OSHG Unit 1 Level Switch/Temperature Transmitter	40 72 76			30-VCP-0800	
PI-0820	30I-608	OSHG Unit 2 Pressure Gauge	40 73 00	I-301	Elastic deformation	30-VCP-0800	
FI-0820	30I-608	OSHG Unit 2 Orfice Flowmeter	40 71 00			30-VCP-0800	
LSL/TT-0820	30I-608	OSHG Unit 2 Level Switch/Temperature Transmitter	40 72 76			30-VCP-0800	
FSL-1010	30I-610	Raw Water Vault Sample Pump Flow Switch Low	40 71 79	I-152	Heat Transfer	PLC-1000 BOP PLC	
PI-1010	30I-610	Raw Water Vault Sample Pump Pressure Gauge	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FI-1010	30I-610	Raw Water Vault Sample Pump Turbidity Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1010	30I-610	Raw Water Vault Sample Pump Turbidity Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FI-1011	30I-610	Raw Water Vault Sample Pump pH/Temp Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1011	30I-610	Raw Water Vault Sample Pump pH/Temp Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FSL-1020	30I-610	Filtered Water Post-Chemical Injection Sample Pump Flow Switch Low	40 71 79	I-152	Heat Transfer	PLC-1000 BOP PLC	
PI-1020	30I-610	Filtered Water Post-Chemical Injection Sample Pump Pressure Gauge	40 73 36	I-301	Elastic deformation	PLC-1000 BOP PLC	
FI-1020	30I-610	Filtered Water Post-Chemical Injection Sample Pump Chlorine Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1020	30I-610	Filtered Water Post-Chemical Injection Sample Pump Chlorine Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FI-1021	30I-610	Filtered Water Post-Chemical Injection Sample Pump pH/Temp Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1021	30I-610	Filtered Water Post-Chemical Injection Sample Pump pH/Temp Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FSL-1030	30I-610	Chlorine Contact Tank Sample Pump Flow Switch Low	40 71 79	I-152	Heat Transfer	PLC-1000 BOP PLC	
PI-1030	30I-610	Chlorine Contact Tank Sample Pump Pressure Gauge	40 73 00	I-301	Elastic deformation	PLC-1000 BOP PLC	
FI-1030	30I-610	Chlorine Contact Tank Sample Pump Chlorine Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1030	30I-610	Chlorine Contact Tank Sample Pump Chlorine Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FI-1031	30I-610	Chlorine Contact Tank Sample Pump pH/Temp Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1031	30I-610	Chlorine Contact Tank Sample Pump pH/Temp Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FSL-1040	30I-610	Membrane Waste Clarifier Sample Pump Flow Switch Low	40 71 79	I-152	Heat Transfer	PLC-1000 BOP PLC	
PI-1040	30I-610	Membrane Waste Clarifier Sample Pump Pressure Gauge	40 73 00	I-301	Elastic deformation	PLC-1000 BOP PLC	
FI-1040	30I-610	Membrane Waste Clarifier Sample Pump Turbidity Rotatmeter	40 71 00	I-106	Paddle Work	PLC-1000 BOP PLC	
AE/AIT-1040	30I-610	Membrane Waste Clarifier Sample Pump Turbidity Analytical Indicating Analyzer	40 75 00			PLC-1000 BOP PLC	
FI-0140	42I-601	Membrane Waste Clarifier Basin Sample Pump Roatameter	40 73 00	I-106	Spring Resistance		
LSH-0105	43I-601	Manhole Level Switch High	40 72 76	I-151	Buoyancy	PLC-1000 BOP PLC	
LSH/L/LL-0105	43I-601	Decant Pump Station Level Switch High/Low/ Low Low	40 72 76	I-151	Buoyancy	PLC-1000 BOP PLC	
TSH-0110	43I-601	Decant Pump No. 1 Temperature Switch High				PLC-1000 BOP PLC	
XS-0110	43I-601	Decant Pump No. 1 Leak Switch				PLC-1000 BOP PLC	
TSH-0120	43I-601	Decant Pump No. 2 Temperature Switch High				PLC-1000 BOP PLC	
XS-0120	43I-601	Decant Pump No. 2 Moisture Switch High				PLC-1000 BOP PLC	
FE/FIT-0150	43I-601	Decant Water Meter Vault Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
LSH-0210A/B	43I-602	Generator Level Switch High	40 72 76			43-LCP-0210	
LSL-0210	43I-602	Generator Level Switch Low	40 72 76			43-LCP-0210	
TSH-0110	45I-601	CIP Waste Pump No. 1 Temperature Switch High				43-VCP-0100	
TSH-0120	45I-601	CIP Waste Pump No. 2 Temperature Switch High				43-VCP-0100	
LSHH/H/L/LL-0110	45I-601	CIP Waste Storage Tank Level Switch High High/High/Low/Low Low	40 72 76	I-151	Buoyancy	45-VCP-0100	
FIT/FE-0115	45I-601	Effluent Waswter Meter Vault Flow Indicating Transmitter	40 71 00	I-101	Magnetic	PLC-1000 BOP PLC	
LSHH/H/L/LL-0210	45I-602	Septic Tank No. 2 Level Switch High High/High/Low	40 72 76	I-151	Buoyancy	45-LCP-0200	
TSH-0210	45I-602	Sump Pump Temperature Switch High				45-LCP-0200	

IO TAG	IO TYPE	DESCRIPTION	PLC	EQUIPMENT TAG	VENDOR IO	DRAWING
FI-0110	AI	Raw Water Vault Intake Flow Indication	PLC-1000 BOP PLC	10-FIT-0110	N	10I-601
PI-0110	AI	Raw Water Vault Intake Pressure Indication	PLC-1000 BOP PLC	10-PIT-0110	N	10I-601
AI-0110	AI	Existing Raw Water Vault pH/Temp Analytical Analyzer	PLC-1000 BOP PLC	10-AIT-0110	N	10I-601
AI-0111	AI	Existing Raw Water Vault Turb Analytical Analyzer	PLC-1000 BOP PLC	10-AIT-0111	N	10I-601
ZK-0107	AO	Raw Water Flow Control Valve Position Setpoint	PLC-1000 BOP PLC	10-MOV-0107	N	10I-601
ZL-0107	DI	Raw Water Flow Control Valve Ready Status	PLC-1000 BOP PLC	10-MOV-0107	N	10I-601
ZLO-0107	DI	Raw Water Flow Control Valve Opened Status	PLC-1000 BOP PLC	10-MOV-0107	N	10I-601
ZLC-0107	AI	Raw Water Flow Control Valve Closed Status	PLC-1000 BOP PLC	10-MOV-0107	N	10I-601
ZI-0107	AI	Raw Water Flow Control Valve Position Feedback	PLC-1000 BOP PLC	10-MOV-0107	N	10I-601
NAHH-0107	DI	Raw Water Flow Control Valve Torque Alarm	PLC-1000 BOP PLC	10-MOV-0107	N	10I-601
YL-0210A	DI	Existing Booster Pump Station Booster Pump No. 1 Run Status	PLC-1000 BOP PLC	12-P-0210	N	12I-601
YL-0210B	DI	Existing Booster Pump Station Booster Pump No. 1 Off Status	PLC-1000 BOP PLC	12-P-0210	N	12I-601
YL-0220A	DI	Existing Booster Pump Station Booster Pump No. 2 Run Status	PLC-1000 BOP PLC	12-P-0220	N	12I-601
YL-0220B	DI	Existing Booster Pump Station Booster Pump No. 2 Off Status	PLC-1000 BOP PLC	12-P-0220	N	12I-601
YL-0230A	DI	Existing Booster Pump Station Booster Pump No. 3 Run Status	PLC-1000 BOP PLC	12-P-0230	N	12I-601
YL-0230B	DI	Existing Booster Pump Station Booster Pump No. 3 Off Status	PLC-1000 BOP PLC	12-P-0230	N	12I-601
HS-0110	DO	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 1 START/STOP Command	PLC-1000 BOP PLC	12-P-0110	N	12I-601
ZL-0110	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 1 In Remote Status	PLC-1000 BOP PLC	12-P-0110	N	12I-601
YL-0110	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 1 Run Status	PLC-1000 BOP PLC	12-P-0110	N	12I-601
YA-0110A	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 1 Fail Alarm	PLC-1000 BOP PLC	12-P-0110	N	12I-601
YA-0110B	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 1 Emergency Stop Alarm	PLC-1000 BOP PLC	12-P-0110	N	12I-601
HS-0120	DO	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 2 START/STOP Command	PLC-1000 BOP PLC	12-P-0120	N	12I-601
ZL-0120	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 2 In Remote Status	PLC-1000 BOP PLC	12-P-0120	N	12I-601
YL-0120	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 2 Run Status	PLC-1000 BOP PLC	12-P-0120	N	12I-601
YA-0120A	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 2 Fail Alarm	PLC-1000 BOP PLC	12-P-0120	N	12I-601
YA-0120B	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 2 Emergency Stop Alarm	PLC-1000 BOP PLC	12-P-0120	N	12I-601
HS-0130	DO	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 3 START/STOP Command	PLC-1000 BOP PLC	12-P-0130	N	12I-601
ZL-0130	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 3 In Remote Status	PLC-1000 BOP PLC	12-P-0130	N	12I-601
YL-0130	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 3 Run Status	PLC-1000 BOP PLC	12-P-0130	N	12I-601
YA-0130A	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 3 Fail Alarm	PLC-1000 BOP PLC	12-P-0130	N	12I-601
YA-0130B	DI	Existing Raw Water Pump Station Raw Water Re-Circulation Pump No. 3 Emergency Stop Alarm	PLC-1000 BOP PLC	12-P-0130	N	12I-601
LAL-0110	DI	Raw Water Pump Station Level Alarm Low	PLC-1000 BOP PLC	12-LSL-0110	N	12I-601
LAH-0110	DI	Raw Water Pump Station Level Alarm High	PLC-1000 BOP PLC	12-LSH-0110	N	12I-601
LI-0110	AI	Raw Water Pump Station Level Indication	PLC-1000 BOP PLC	12-LIT-0110	N	12I-601
UI-0113	UI	Containerized Membrane Filtration System	MCP-MS		Y	20I-601
FI-0140	AI	Filtered Water Meter and Chemical Injection Vault Intake Flow Indication	PLC-1000 BOP PLC	20-FIT-0140	N	20I-601
FQI-0140	AI	Filtered Water Meter and Chemical Injection Vault Intake Average Flow Indication	PLC-1000 BOP PLC	20-FIT-0140	N	20I-601
LAL-0140	DI	Filtered Water Meter and Chemical Injection Vault Leak Alarm	PLC-1000 BOP PLC	20-LSH-0140	N	20I-601
LAH-0110	DI	Chlorine Contact Tank Level Alarm High	PLC-1000 BOP PLC	25-LAH-0110	N	25I-601
AI-0115	AI	Existing Chlorine Residual Indication	PLC-1000 BOP PLC	25-AIT-0115	N	25I-601
LI-0120	AI	Existing Carson Reservoir Level Indication	PLC-1000 BOP PLC	25-LIT-0120	N	25I-601
LAH-0120	DI	Existing Carson Reservoir Level Alarm High	PLC-1000 BOP PLC	25-LSH-0120	N	25I-601
LI-0210	AI	Existing Brooks Reservoir Level Indication	PLC-1000 BOP PLC	25-LIT-0210	N	25I-601
XA-0210	DI	Existing Brooks Alarms	PLC-1000 BOP PLC	25-XS-0210	N	25I-601
LI-0110	AI	Neutralization Dechlorination Off-Skid Tank	MCP-MS	30-LIT-0110	Y	30I-601
LAHH-0110	DI	Neutralization Dechlorination Off-Skid Tank Level Alarm High High	MCP-MS	30-LSHH-0110	Y	30I-601
LALL-0110	DI	Neutralization Dechlorination Off-Skid Tank Level Alarm Low Low	MCP-MS	30-LSLL-0110	Y	30I-601
HS-0120A	DO	Neutralization Skid Pump START Command	MCP-MS	30-P-0120	Y	30I-601
HS-0120B	DO	Neutralization Skid Pump STOP Command	MCP-MS	30-P-0120	Y	30I-601
ZL-0120	DI	Neutralization Skid Pump In Auto Status	MCP-MS	30-P-0120	Y	30I-601
YL-0120	DI	Neutralization Skid Pump Run Status	MCP-MS	30-P-0120	Y	30I-601
YA-0120A	DI	Neutralization Skid Pump Fail Alarm	MCP-MS	30-P-0120	Y	30I-601
YA-0120B	DI	Neutralization Skid Pump Emergency Stop Alarm	MCP-MS	30-P-0120	Y	30I-601
FAL-0120	DI	Neutralization Skid Pump Flow Alarm Low	MCP-MS	30-P-0120	Y	30I-601

IO TAG	IO TYPE	DESCRIPTION	PLC	EQUIPMENT TAG	VENDOR IO	DRAWING
TAH-0120	DI	Neutralization Skid Pump Temperature Alarm High	MCP-MS	30-P-0120	Y	30I-601
AI-0120	AI	Neutralization Skid Pump Discharge pH/ORP Analyzer	MCP-MS	30-AIT-1020	Y	30I-601
LI-0201	AI	Aluminum Chlorohydrate Bulk Tank Level Indication	PLC-1000 BOP PLC	30-LT-0201	N	30I-602
LALL-0201	DI	Aluminum Chlorohydrate Bulk Tank Level Alarm Low Low	PLC-1000 BOP PLC	30-LT-0201	N	30I-602
HS-0210A	DO	Aluminium Chlorohydrate Feed Pump No. 1 START Command	PLC-1000 BOP PLC	30-P-0210	N	30I-602
HS-0210B	DO	Aluminium Chlorohydrate Feed Pump No. 1 STOP Command	PLC-1000 BOP PLC	30-P-0210	N	30I-602
ZL-0210	DI	Aluminium Chlorohydrate Feed Pump No. 1 In Remote Status	PLC-1000 BOP PLC	30-P-0210	N	30I-602
YL-0210	DI	Aluminium Chlorohydrate Feed Pump No. 1 Run Status	PLC-1000 BOP PLC	30-P-0210	N	30I-602
YA-0210	DI	Aluminium Chlorohydrate Feed Pump No. 1 Fail Alarm	PLC-1000 BOP PLC	30-P-0210	N	30I-602
SI-0210	AI	Aluminium Chlorohydrate Feed Pump No. 1 Speed Indication	PLC-1000 BOP PLC	30-P-0210	N	30I-602
SC-0210	AO	Aluminium Chlorohydrate Feed Pump No. 1 Speed Setpoint	PLC-1000 BOP PLC	30-P-0210	N	30I-602
PAH-0210	DI	Aluminium Chlorohydrate Feed Pump No. 1 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0210	N	30I-602
HS-0220A	DO	Aluminium Chlorohydrate Feed Pump No. 2 START Command	PLC-1000 BOP PLC	30-P-0220	N	30I-602
HS-0220B	DO	Aluminium Chlorohydrate Feed Pump No. 2 STOP Command	PLC-1000 BOP PLC	30-P-0220	N	30I-602
ZL-0220	DI	Aluminium Chlorohydrate Feed Pump No. 2 In Remote Status	PLC-1000 BOP PLC	30-P-0220	N	30I-602
YL-0220	DI	Aluminium Chlorohydrate Feed Pump No. 2 Run Status	PLC-1000 BOP PLC	30-P-0220	N	30I-602
YA-0220	DI	Aluminium Chlorohydrate Feed Pump No. 2 Fail Alarm	PLC-1000 BOP PLC	30-P-0220	N	30I-602
SI-020	AI	Aluminium Chlorohydrate Feed Pump No. 2 Speed Indication	PLC-1000 BOP PLC	30-P-0220	N	30I-602
SC-0220	AO	Aluminium Chlorohydrate Feed Pump No. 2 Speed Setpoint	PLC-1000 BOP PLC	30-P-0220	N	30I-602
PAH-0220	DI	Aluminium Chlorohydrate Feed Pump No. 2 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0220	N	30I-602
HS-0230A	DO	Aluminium Chlorohydrate Feed Pump No. 3 START Command	PLC-1000 BOP PLC	30-P-0230	N	30I-602
HS-0230B	DO	Aluminium Chlorohydrate Feed Pump No. 3 STOP Command	PLC-1000 BOP PLC	30-P-0230	N	30I-602
ZL-0230	DI	Aluminium Chlorohydrate Feed Pump No. 3 In Remote Status	PLC-1000 BOP PLC	30-P-0230	N	30I-602
YL-0230	DI	Aluminium Chlorohydrate Feed Pump No. 3 Run Status	PLC-1000 BOP PLC	30-P-0230	N	30I-602
YA-0230	DI	Aluminium Chlorohydrate Feed Pump No. 3 Fail Alarm	PLC-1000 BOP PLC	30-P-0230	N	30I-602
SI-0230	AI	Aluminium Chlorohydrate Feed Pump No. 3 Speed Indication	PLC-1000 BOP PLC	30-P-0230	N	30I-602
SC-0230	AO	Aluminium Chlorohydrate Feed Pump No. 3 Speed Setpoint	PLC-1000 BOP PLC	30-P-0230	N	30I-602
PAH-0230	DI	Aluminium Chlorohydrate Feed Pump No. 3 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0230	N	30I-602
PI-0320	AI	Water Softner Vendor Package Discharge Pressure Level Indication	PLC-1000 BOP PLC	30-PIT-0320	N	30I-603
LI-0350	DSAI	Sodium Hypochlorite Storage Tank Level Indication	PLC-1000 BOP PLC	30-LIT-0350	N	30I-603
LAL-0350	DSDI	Sodium Hypochlorite Storage Tank Leak Alarm	PLC-1000 BOP PLC	30-LSH-0350	N	30I-603
HS-0410A	DO	Sodium Hypochlorite Feed Pump No. 1 START Command	PLC-1000 BOP PLC	30-P-0410	N	30I-604
HS-0410B	DO	Sodium Hypochlroite Feed Pump No. 1 STOP Command	PLC-1000 BOP PLC	30-P-0410	N	30I-604
ZL-0410	DI	Sodium Hypochlorite Feed Pump No. 1 In Remote Status	PLC-1000 BOP PLC	30-P-0410	N	30I-604
YL-0410	DI	Sodium Hypochlorite Feed Pump No. 1 Run Status	PLC-1000 BOP PLC	30-P-0410	N	30I-604
YA-0410	DI	Sodium Hypochlorite Feed Pump No. 1 Fault Alarm	PLC-1000 BOP PLC	30-P-0410	N	30I-604
SI-0410	AI	Sodium Hypochlorite Feed Pump No. 1 Speed Indication	PLC-1000 BOP PLC	30-P-0410	N	30I-604
SC-0410	AO	Sodium Hypochlorite Feed Pump No. 1 Speed Setpoint	PLC-1000 BOP PLC	30-P-0410	N	30I-604
PAH-0410	DI	Sodium Hypochlorite Feed Pump No. 1 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0410	N	30I-604
HS-0420A	DO	Sodium Hypochlorite Feed Pump No. 2 START Command	PLC-1000 BOP PLC	30-P-0420	N	30I-604
HS-0420B	DO	Sodium Hypochlroite Feed Pump No. 2 STOP Command	PLC-1000 BOP PLC	30-P-0420	N	30I-604
ZL-0420	DI	Sodium Hypochlorite Feed Pump No. 2 In Remote Status	PLC-1000 BOP PLC	30-P-0420	N	30I-604
YL-0420	DI	Sodium Hypochlorite Feed Pump No. 2 Run Status	PLC-1000 BOP PLC	30-P-0420	N	30I-604
YA-0420	DI	Sodium Hypochlorite Feed Pump No. 2 Fault Alarm	PLC-1000 BOP PLC	30-P-0420	N	30I-604
SI-0420	AI	Sodium Hypochlorite Feed Pump No. 2 Speed Indication	PLC-1000 BOP PLC	30-P-0420	N	30I-604
SC-0420	AO	Sodium Hypochlorite Feed Pump No. 2 Speed Setpoint	PLC-1000 BOP PLC	30-P-0420	N	30I-604
PAH-0420	DI	Sodium Hypochlorite Feed Pump No. 2 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0420	N	30I-604
PAH-0430	AI	Sodium Hypochlorite Transfer Pump Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0430	N	30I-604
FI-0430	AI	Sodium Hypochlorite Discharge Flow Indication	PLC-1000 BOP PLC	30-FIT-0430	N	30I-604
FAH-0501	DI	Hypo-Caustic Emergency Eyewash On Switch	PLC-1000 BOP PLC	30-FSH-0501	N	30I-605
LI-0501	AI	Sodium Hypdroxide Bulk Tank Level Indication	PLC-1000 BOP PLC	30-LIT-0501	N	30I-605
LALL-0501	DI	Sodium Hypdroxide Bulk Tank Level Alarm Low Low	PLC-1000 BOP PLC	30-LIT-0501	N	30I-605
HS-0510A	DO	Sodium Hyrdoxide Feed Pump No. 1 START Command	PLC-1000 BOP PLC	30-P-0510	N	30I-605
HS-0510B	DO	Sodium Hyrdoxide Feed Pump No. 1 STOP Command	PLC-1000 BOP PLC	30-P-0510	N	30I-605

IO TAG	IO TYPE	DESCRIPTION	PLC	EQUIPMENT TAG	VENDOR IO	DRAWING
ZL-0510	DI	Sodium Hydroxide Feed Pump No. 1 In Remote Status	PLC-1000 BOP PLC	30-P-0510	N	30I-605
YL-0510	DI	Sodium Hydroxide Feed Pump No. 1 Run Status	PLC-1000 BOP PLC	30-P-0510	N	30I-605
YA-0510	DI	Sodium Hydroxide Feed Pump No. 1 Fail Alarm	PLC-1000 BOP PLC	30-P-0510	N	30I-605
SI-0510	AI	Sodium Hydroxide Feed Pump No. 1 Speed Indication	PLC-1000 BOP PLC	30-P-0510	N	30I-605
SC-0510	AO	Sodium Hydroxide Feed Pump No. 1 Speed Setpoint	PLC-1000 BOP PLC	30-P-0510	N	30I-605
PAH-0510	DI	Sodium Hydroxide Feed Pump No. 1 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0510	N	30I-605
HS-0520A	DO	Sodium Hyrdoxide Feed Pump No. 2 START Command	PLC-1000 BOP PLC	30-P-0520	N	30I-605
HS-0520B	DO	Sodium Hyrdoxide Feed Pump No. 2 STOP Command	PLC-1000 BOP PLC	30-P-0520	N	30I-605
ZL-0520	DI	Sodium Hydroxide Feed Pump No. 2 In Remote Status	PLC-1000 BOP PLC	30-P-0520	N	30I-605
YL-0520	DI	Sodium Hydroxide Feed Pump No. 2 Run Status	PLC-1000 BOP PLC	30-P-0520	N	30I-605
YA-0520	DI	Sodium Hydroxide Feed Pump No. 2 Fail Alarm	PLC-1000 BOP PLC	30-P-0520	N	30I-605
SI-0520	AI	Sodium Hydroxide Feed Pump No. 2 Speed Indication	PLC-1000 BOP PLC	30-P-0520	N	30I-605
SC-0520	AO	Sodium Hydroxide Feed Pump No. 2 Speed Setpoint	PLC-1000 BOP PLC	30-P-0520	N	30I-605
PAH-0520	DI	Sodium Hydroxide Feed Pump No. 2 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0520	N	30I-605
PAH-0530	DI	Sodium Hydroxide Tranfser Pump No. 1 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0530	N	30I-605
FI-0530	AI	Sodium Hydroxide Transfer Pump No. 1 Discharge Flow Indication	PLC-1000 BOP PLC	30-FIT-0530	N	30I-605
PAH-0540	DI	Sodium Hydroxide Tranfser Pump No. 2 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0540	N	30I-605
FI-0540	AI	Sodium Hydroxide Transfer Pump No. 2 Discharge Flow Indication	PLC-1000 BOP PLC	30-FIT-0540	N	30I-605
WI-0601	AI	Citric Acid Tote Weight Indication	PLC-1000 BOP PLC	WIT-0601	N	30I-606
FAH-0602	DI	Chloro-Thio Emergency Eyewash On Switch	PLC-1000 BOP PLC	FSH-0602	N	30I-606
PAH-0610	DI	Citric Acid Tranfser Pump No. 1 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0610	N	30I-606
FI-0610	AI	Citric Acid Transfer Pump No. 1 Discharge Flow Indication	PLC-1000 BOP PLC	30-FIT-0610	N	30I-606
PAH-0620	DI	Citric Acid Tranfser Pump No. 2 Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0620	N	30I-606
FI-0620	AI	Citric Acid Transfer Pump No. 2 Discharge Flow Indication	PLC-1000 BOP PLC	30-FIT-0620	N	30I-606
PAH-0710	DI	Calcium Thiosulfate Discharge Pressure Alarm High	PLC-1000 BOP PLC	30-PSH-0710	N	30I-607
FI-0710	AI	Calcium Thiosulfate Transfer Pump Discharge Flow Indication	PLC-1000 BOP PLC	30-FIT-0710	N	30I-607
YA-0810A	DSDI	OSHG Unit 1 Error Alarm	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
YL-0810A	DSDI	OSHG Unit 1 System Ready Status	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
YL-0810B	DSDI	OSHG Unit 1 Prep On Status	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
YL-0810C	DSDI	OSHG Unit 1 Dosing Enable Status	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
YA-0810B	DSDI	OHSG Unit 1 Stop Active Alarm	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
HS-0810A	DSDO	OSHG Unit 1 Remote Enable Command	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
HS-0810B	DSDO	OSHG Unit 1 E-Stop Command	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
LAL-0810	DSDI	OSHG Unit 1 Level Alarm Low	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
TI-0810	DSAI	OSHG Unit 1 Temperature Indication	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
EI-0811	DSAI	OSHG Unit 1 Voltage Indication	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
II-0811	DSAI	OSHG Unit 1 Amps Indication	PLC-1000 BOP PLC	30-VCP-0810	Y	30I-608
YA-0820A	DSDI	OSHG Unit 2 Error Alarm	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
YL-0820A	DSDI	OSHG Unit 2 System Ready Status	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
YL-0820B	DSDI	OSHG Unit 2 Prep On Status	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
YL-0820C	DSDI	OSHG Unit 2 Dosing Enable Status	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
YA-0820B	DSDI	OHSG Unit 2 Stop Active Alarm	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
HS-0820A	DSDO	OSHG Unit 2 Remote Enable Command	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
HS-0820B	DSDO	OSHG Unit 2 E-Stop Command	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
LAL-0820	DSDI	OSHG Unit 2 Level Alarm Low	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
TI-080	DSAI	OSHG Unit 2 Temperature Indication	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
EI-0821	DSAI	OSHG Unit 2 Voltage Indication	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
II-0821	DSAI	OSHG Unit 2 Amps Indication	PLC-1000 BOP PLC	30-VCP-0820	Y	30I-608
AI-0830	AI	Analytical Analyzer Hydrogen Gas Indication	PLC-1000 BOP PLC	30-AIT-0830	N	30I-608
AAH-0830	DI	Analytical Analyzer Hydrogen Gas Alarm High	PLC-1000 BOP PLC	30-AIT-0830	N	30I-608
HS-0830A	DO	Horn Near Southwest Door Silence Horn	PLC-1000 BOP PLC	30-FSL-1010	N	30I-610
HS-0830B	DO	Horn Near Southwest Door Turn Off Beacon	PLC-1000 BOP PLC	30-AIT-1010	N	30I-610
HS-0830C	DO	Horn Near Northeast Door Silence Horn	PLC-1000 BOP PLC	30-AIT-1011	N	30I-610
HS-0830D	DO	Horn Near Northeast Door Turn Off Beacon	PLC-1000 BOP PLC	30-AIT-1011	N	30I-610

SECTION 40 91 00 - PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide Process Control and Instrumentation Systems (PCIS) complete and operable, in accordance with the Contract Documents. For the purpose of this Contract, PCIS is synonymous and interchangeable with supervisory control and data acquisition (SCADA) and distributed control system (DCS), where applicable. The requirements of this Section apply to every component of the PCIS unless indicated otherwise.

B. Responsibilities

1. The Contractor, through the use of a single System Supplier and qualified electrical and mechanical installers, shall be responsible to the Owner for the implementation of the PCIS and the integration of the PCIS with other required instrumentation and control devices.

2. Due to the complexities associated with the interfacing of numerous control system devices, the intent of these specifications is that the System Supplier will be responsible to the Contractor for the integration of the PCIS with existing devices and devices provided under this and other Divisions with the objective of providing a completely integrated control system free of signal incompatibilities.

3. The Contractor shall request the Owner to demonstrate that all existing equipment that is to be reused or interfaced with in this project works properly for the intended function. In the event the existing equipment does not work, the issue should be brought up in the preconstruction/pre-submittal meeting(s).

4. As a minimum, the implementation of the PCIS by the Contractor shall include the following WORK:

a. Integrate the PCIS with existing devices and systems provided under this and other Divisions

b. Prepare the required PCIS submittals

c. Design and develop project-wide loop diagrams including those associated with equipment provided under other Divisions and Owner-furnished and existing equipment

d. Design and develop control panel drawings

e. Field verify existing conditions

f. Prepare factory and field test submittals

g. Preparing training plan

h. Prepare spare parts submittal

i. Procure hardware and software

j. Configure and factory test the PCIS

k. Bench calibrate instruments and verify calibration after installation

l. Terminate signals inside control and network panels; terminate communication and network devices and nodes

m. Supervise and coordinate installation and termination of field signals, power, and utilities associated with the PCIS. Resolve signal, power, or functional incompatibilities between the PCIS and new and existing interfacing devices.

n. Loop test in accordance with the loop diagrams. Validate and certify loops

o. Oversee, document, and certify system commissioning

p. Conduct system performance test

q. Prepare technical manuals

r. Conduct training classes

s. Prepare PCIS as-built final construction drawings

5. Any Instrumentation Supplier responsibilities in addition to the list above are at the discretion of the Contractor and the Instrumentation Supplier. Additional requirements in this Section and throughout Division 40 that are stated to be the Contractor's responsibility may be performed by the Instrumentation Supplier if the Contractor and Instrumentation Supplier agree.

1.2 RELATED WORK AND REQUIREMENTS SPECIFIED ELSEWHERE

A. All electrical work required under this section shall conform to the requirements of this Section and the applicable requirements of the Sections in Division 01, Division 26, and Division 27.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Without limiting the generality of other requirements of these Specifications, all WORK specified herein shall conform to or exceed the applicable requirements of the referenced documents to the extent that the requirements therein are not in conflict with the provisions of this Section; provided that where such documents have been adopted

as a code or ordinance by the public agency having jurisdiction, such code or ordinance shall take precedence.

C. Definitions

1. System Supplier**:** The System Supplier shall be a single firm, corporation, or other entity assuming full responsibility through the Contractor to perform all engineering and to select, furnish, program, configure, integrate, supervise the installation and connections, test, calibrate, and place into operation all instrumentation, controls, communication hardware and software. The System Supplier shall specialize and have an experienced engineering and technical staff in the design, integration, and supply of systems similar to the one in these Contract Documents. The term "System Supplier" shall mean the same as "SCADA System Supplier" or "PCIS Supplier."

D. The PCIS WORK shall conform to or exceed the applicable regulations, standards, specifications, and codes which are referenced in Section 01 42 19 Reference Standards, and current as of the date of the final inspection for this Contract, including, but not limited to, those which are established by the following sources:

1. The International Society of Automation (ISA)
2. National Electrical Code (NEC)
3. National Fire Protection Association (NFPA)
4. Institute of Electrical and Electronic Engineers (IEEE)
5. Occupational Safety and Health Administration (OSHA)
6. American National Standards Institute (ANSI)
7. National Electrical Manufacturers Association (NEA)
8. Insulated Cable Engineers Association (ICEA)
9. Local Power and Telephone Companies
10. Local Authorities having jurisdiction over the work
11. Federal Communication Commission (FCC)
12. Underwriter Laboratory (UL)

E. Where the requirements set forth in these Specifications or on the Drawings are greater or more rigid than the mandatory requirements referenced above, the applicable Specifications or Drawings shall govern.

F. In the case of conflict between any mandatory requirements and Specifications or Drawings, the mandatory requirement shall be followed in each case, but only after submitting such proposed changes to the Engineer for approval.

G. Nothing contained in these Specifications or shown on the Drawings will be so construed to conflict with any national, state, municipal, or local laws or regulations governing the installation of work specified herein, and all such acts, ordinances, and regulations, including the National Electrical Code, are hereby incorporated and made a part of these Specifications. All such requirements will be satisfied by the Contractor at no additional expense to the Owner.

H. The Drawings and Specifications are complementary to each other; what is called for by one shall be as binding as if called for by both. If a conflict between Drawings and Specifications is discovered, this shall be referred to the Engineer as soon as possible for resolution. Should a conflict exist between the Drawings, Specifications, and/or mandatory requirements (i.e., codes, ordinances, etc.), it will be assumed that the more expensive method has been estimated, unless such alternate has been agreed to prior to submission of bids.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-submittal Conference

1. The Contractor shall arrange and conduct a Pre-submittal Conference within 30 Days after award of the Contract. The purpose of the Pre-submittal Conference is to review and approve the manner in which the Contractor intends to carry out its responsibilities for Shop Drawing submittal on the WORK to be provided under this Section. The Contractor, the System Supplier, and the Engineer shall attend. Both the Contractor and the Engineer may invite additional parties at their discretion.

2. Before preparing the submittals, the Contractor shall meet with the Owner and visit the project site(s) to obtain information and inventory regarding the existing conditions. Interface to existing equipment, control, and monitoring circuits shall also be reviewed. During the inventory, the Contractor shall determine the location of the new equipment that is part of this contract. Any major conflicts with the contract documents shall be brought to the Engineer’s attention at the pre-submittal conference. The Contractor shall also review the available as-built drawings.

3. The Contractor shall allot two, 8 hour days for the pre-submittal conference.

4. The Contractor shall present the following for discussion at the pre-submittal conference:

a. A list of equipment and materials required for the PCIS and the manufacturer's name and model number for each proposed item.

b. A list of requests for clarifications (RFC) or information (RFI) for the contract documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the Engineer.

c. An exact one-to-one sample of each type of submittal herein.

d. A bar-chart type schedule for system-related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design, fabrication, programming, factory testing, deliveries, installation, field testing,

and training shall be shown. The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.

5. The Contractor shall take minutes of the pre-submittal conference, including events, questions, and resolutions. Prior to adjournment, attendees must concur with the accuracy of the minutes and sign accordingly.

1.5 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. The Contractor shall provide submittals in accordance with Section 01 33 00 - Submittal Procedures and the additional submittal requirements specified in this Section, in Division 40, and the following:

1. The Contractor shall coordinate the PCIS part of the WORK so that a complete instrumentation and control system will be provided and will be supported by accurate Shop Drawings and as-built drawings.

2. The submittals and their schedules shall be in accordance with the requirements listed below: Any incomplete submittal will be rejected and returned without comments.

3. Interface between instruments, motor control centers, engines, starters, control valves, flowmeters, and other equipment related to the PCIS shall be included in the shop drawing submittal. Interface between existing equipment, instruments and control panels shall also be included,

4. Exchange of Technical Information: During the period of preparation of these submittals, the Contractor shall authorize a direct, informal liaison with the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as indicated may be authorized informally by the Engineer but will not alter the scope of WORK or cause an increase or decrease in the Contract Price. During this informal exchange, no oral statement by the Engineer shall be construed to give approval of any component or method, nor shall any statement be construed to grant exception to or variation from these Contract Documents.

5. Symbols and Nomenclature: In these Contract Documents, systems, meters, instruments, and other elements are represented schematically, and are designated by symbols as derived from Instrument Society of America Standard ISA S5.1 - Instrumentation Symbols and Identification. The nomenclature and numbers designated herein and, on the Drawings, shall be employed exclusively throughout Shop Drawings, and similar materials. No other symbols, designations, or nomenclature unique to the manufacturer's standard methods shall replace those prescribed above, used herein, or on the Drawings.

B. Shop Drawings Submittal Organization

1. Shop Drawings shall include the letter head or title block of the System Supplier. The title block shall include, as a minimum, the System Supplier's registered business name and address, project name, drawing name, revision level, and personnel responsible for the content of the drawing.

2. Organization of the Shop Drawing submittals shall be compatible with eventual submittals for later inclusion in the Technical Manual. Submittals not so organized will not be accepted.

3. For a project with multiple sites, the Contractor shall provide a separate and unique set of drawings for each site.

4. Drawings that require more than one sheet due to space limitation or continuation in the subject of the drawings (e.g., loop diagrams, etc.) shall be given the same drawing number but with different sheet number (e.g., sheet 1 of x, sheet 2 of x, etc.).

5. Each submittal shall include a complete index appearing in the front of each bound submittal volume. Drawings and/or system groups shall be separated by labeled tags. The organization of the initial shop drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting as-built conditions.

6. Interfaces between new and existing instruments, motor starters, control valves, variable speed drives, flow meters, chemical feeders, panels, and other equipment related to the PCIS shall be included in the Shop Drawing submittal.

C. Field Instrument Submittal

1. Submittal Schedule: The Contractor shall submit for approval a complete field and process instrument submittal, **all at one time, within 60 calendar days** after the date of Notice to Proceed is given to the Contractor.

2. Submittal Contents: The submittal shall include a complete index which lists each device by tag number, type, and manufacturer in accordance with the specified data sheets provided in this Contract. A separate manufacturer technical brochure or catalog sheet shall be included with each specified instrument data sheet. If, within a single system or loop, a single instrument is employed more than once, one manufacturer's brochure or catalog sheet may cover multiple identical uses of that instrument in that system. Each manufacturer's brochure or catalog sheet shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags. Special options and features which are furnished shall be identified.

D. System Hardware Submittal:

1. Submittal Schedule: The Contractor shall submit for approval a complete system hardware submittal, **all at one time, within 90 calendar days** after the date of Notice to Proceed is given to the Contractor. This submittal shall be submitted together with the submittal for the System Architecture, and Communication Diagrams submittal and the Project-Wide Wiring Diagrams and Panel Drawings submittal specified below.

2. Submittal Contents:

a. The submittal shall be for the hardware specified under Sections 40 95 10 – PLC -Based Control System Hardware and 40 67 00 - Control System Equipment Panels and Racks.

b. The submittal shall include a complete index which lists each device by type and manufacturer in accordance with the contract documents. A separate manufacturer technical data sheet or brochure shall be included for each hardware component. If, within a single system a single component is employed more than once, one manufacturer technical data sheet or brochure may cover multiple identical uses of that component in that system. Special options and features which are furnished shall be identified.

c. The submittal shall include load calculations and size of the various UPS systems to demonstrate that the UPS is able to accommodate present and future load requirements, as well as overload capacity requirements.

d. Spare Parts and Tools List: A list of spare parts and tools shall be submitted, covering items which are specified and furnished under this Contract. The list shall include the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts. The list shall also include recommended spare parts and tools, quantities, and prices from which the Owner will select the "Additional Recommended Spare Parts and Tools".

E. System Software Submittal

1. Submittal Schedule: The Contractor shall submit for approval a complete system hardware submittal, **all at one time, within 90 calendar days** after the date of Notice to Proceed

2. Submittal Contents:

a. The submittal shall be for the software specified under Section 40 95 20 – PLC-Based Control System Software. This submittal shall be provided in a singular all-inclusive submittal and be made separately from other PCIS submittals.

b. The software submittal shall include but not be limited to:

1) Vendor documentation that supports the specific functional requirements of the contract documents Section 40 95 20 – PLC-Based Control System Software are met. Details shall include complete description of the standard (baseline) application Human Machine Interface (HMI) software programs, operating system, and utility programs to be furnished, including modifications and explanation of how the specific functional requirement will be met. A cross reference between the specification and the software submittal shall be provided in order to provide the Engineer with the ability to identify how each specified section or function is being met by the Contractor.

2) A functional design report of the implemented control functions using as a reference to the strategies specified in Section 40 90 10 – Control Strategies. The report shall include:

a) Control narratives and their implementation, which describe all monitoring and control functions (e.g., commands, mission, anticipated action, etc.) on a loop by loop or site by site basis in the PLC. It shall also describe special control functions in the server(s), including peer-to-peer communication. These narratives will be used for the operating instructions and inclusion in the Operations and Maintenance Manuals.

b) Control narratives shall enumerate the signal point name, signal description, associated PLC number, associated graphic displays, system functions activated by the signal (i.e., interlocks, alarms, logs, etc.)

c) A complete set of all available software algorithms with annotation of:

1) Individual coil register and variable description

2) Program, group of program, subroutine, and complete rung detail comments

3) Memory, coil, register, and variable usage mapping

d) Description of how the HMI software will be configured to meet the requirements specified in Section 40 95 20 – PLC-Based Control System Software.

e) Copies of the configured PLC control software shall be provided in the technical manual together with a CD.

F. Input and Output (I/O) Data List:

1. Submittal Schedule: The Contractor shall submit for approval a complete I/O list(s), **all at one time, within 90 calendar days** after the date of Notice to Proceed is given to the Contractor.

2. Submittal Contents:

a. The submittal shall include a complete listing of the PCIS I/O data base listing for each data point relevant parameters such as range, active state, contact orientation, limits, incremental limits, and I/O hardware address. The list shall be divided and grouped on a site-by-site basis and PLC assignment and divided into type of I/O's (card type). The I/Os shall be identified by the location of the card (slot no.) and input/output point number. The list I/O shall be formatted in MS Excel.

b. In addition to the active I/O's, the list shall also include the implemented spare I/O's and the available I/O's remaining on the I/O board.

G. System Architecture and Communication Diagrams

1. Submittal Schedule: The Contractor shall submit for approval a complete set of system architecture and communication diagrams **all at one time within 120 calendar days** after the date of Notice to Proceed is given to the Contractor. This submittal shall be submitted together with the System Hardware submittal and the Project-Wide Wiring Diagrams and Panel Drawings submittal specified herein.

2. Submittal Contents: System Architecture and Communication System Diagrams: The Contractor shall develop and submit project-wide system architecture and communication diagrams, which present the system architecture, the network(s), and radio communication as applicable. The submittal shall include a set of drawings that presents the following as applicable:

   a. System architecture and network (copper and fiber optic) physical topology schematic, including servers, workstations, hardware nodes, network hardware such as routers, cabling converters, etc., and connections.

   b. System architecture and network (copper and fiber optic) physical topology schematic, including servers, workstations, hardware nodes, network hardware such as routers, cabling converters, etc., and connections.

   c. Radio communication, cabling and connections, including within a panel and the antenna.

H. Project-Wide Wiring Diagrams and Panel Drawings Submittal:

1. Submittal Schedule: The Contractor shall submit for approval a complete set of project-wide wiring diagrams (PWWD) and panel drawings, **all at one time within 120 calendar days** after the date of Notice to Proceed is given to the Contractor. The PWWD and panel drawings shall be a singular complete hard copy bound package and accompanied with a PDF on a CD. This submittal shall be submitted together with the System Hardware submittal and the System Architecture and Communication Diagrams submittal specified herein.

2. Submittal Contents: The PWWD and panel drawings shall be submitted as a single and comprehensive set of drawings. The submittal shall include a complete index in the front of each part of the submittal. The drawings shall be indexed by systems, sites, or process areas. Diagrams shall be tagged in a manner consistent with the Contract Documents and shall include the following:

   a. Project-Wide Wiring Diagrams: The PWWD shall define and document the contents of each analog and discrete monitoring, alarming, hardware interlock, and control functions associated with equipment provided under Division 40 sections. The PWWD also cover equipment provided under sections in other Divisions, existing, and Owner-furnished equipment. The PWWD shall also include both field and panel wiring diagrams.

      1) Drawings showing definitive diagrams for every analog and discrete instrumentation loop system. These diagrams shall show and identify each component in each loop or system using legend and symbols from

the standards in the Contract Documents. The wiring diagrams shall be presented on an 11"x17" drawing with no more than 10 loops per drawing.

2) In general, loops shall be grouped and organized by PLC (if used) and the I/O cards within the PLC. Each I/O card shall be presented on a separate sheet(s) and on the right side of the drawing. The type of card, part number, and its slot location shall be identified. Each I/O shall be identified as well as its location on the card and its address. Existing, spare, and future I/Os shall also be shown. Power supply wiring to the card/loops, wire colors, and terminal numbers shall be shown on the wiring diagrams. The I/O cards, the loops, and any device in the loop shall be shown together. Each loop shall be complete, including the source/destination within new or existing panels, device(s) in the loop, field connection panels or field junction boxes, field and PLC interface terminal blocks and wire numbers.

3) In addition, wiring diagrams shall show the following details

a) Functional name of each loop

b) Reference name, drawing, and loop diagram numbers for any signal continuing off the wiring diagram sheet.

c) MCC panel, circuit, and breaker numbers for power feeds to the loops and instrumentation.

d) Wiring type, size, and color

e) Designation, and if applicable, terminal assignments associated with every manhole, pull box, junction box, conduit in which wiring is to be located, and panel through which the loop circuits pass.

f) Vendor panel, instrument panel, conduit, junction boxes, equipment and SCADA terminations, termination identification wire numbers and colors, power circuits, and ground identifications.

4) Wiring diagrams shall be developed for loops in equipment vendor-supplied packages, equipment provided under Division 40, and Owner-furnished equipment.\

b. Panel Wiring Diagrams: Panel wiring and/or piping diagrams shall be prepared in concert with the PWWD and shall include the following information:

1) Name of panel

2) Power distribution schematic diagrams associated with each panel or system (120VAC, 24VDC, and other DC systems, control circuits). The schematic diagram shall show source of power for the panel (circuit breaker panel and breaker) and fuses. All power backup system distribution shall also be shown.

3) Schematic diagrams for control circuits in accordance with ANSI standards. The diagrams show complete details on the circuit interrelationship of all devices within and outside each Control Panel. Including primary measurement and control devices.

4) Communication diagram(s) for the equipment inside the panel.

5) Interfaces with existing control and monitoring systems. The Contractor shall furnish all necessary diagrams that depict any and all modifications made to existing measurement and control circuits, equipment, and wiring. It is the responsibility of the System Supplier to ascertain actual field conditions of the existing circuits, equipment, and wiring. The Contractor may request copies of as-built drawings and data that the Owner can provide that show such existing conditions. Lack of such drawings shall not alleviate the contractual responsibility to ascertain and implement interfaces and modifications to existing measurement and control circuits, equipment, and wiring.

6) Surge protection and signal and safety grounding circuits

7) Wiring type and piping size and material

8) Terminal block numbers and wire numbers

c. Panel Drawings: Panel drawings, including console and cabinet layout drawings, shall be prepared and submitted for each panel and shall include the following information: These drawings shall include enough other details to define exactly the style, the contents, and overall appearance of the panel assembly.

1) Name of Panel.

2) Panel Dimensions; front, side, and plan views and layout to scale.

3) Arrangement of internally and externally mounted instruments and equipment to scale. Note: Control panel layouts shown on the Contract Drawings are diagrammatic.

4) Location of terminal blocks, electrical devices, and conduit entry location(s).

5) Tag number or item number and functional name of items mounted in and on panel, console, or cabinet.

6) Nameplate legend which includes text, letter size, and colors to be used.

7) Complete and detailed Bills of Materials shall include all items within a panel and shall be presented on the panel layout drawing. The bill of material list shall include quantity, description, manufacturer, and part number.

8) Panel mounting information, including conduit entrance location.

9) Communication hardware installation, such as radio, mast, and antenna.

10) Assembly and construction drawings. These drawings shall include dimensions, identification of all components, construction material and gauge, surface preparation and finish data, panel door locks and hinge mechanism, nameplates, and the like.

I. Display and Report Submittals:

1. Submittal Schedule:

a. After all Software Submittals have been approved by the Engineer, but **30 calendar days** prior to the requisite Graphics and Report Meetings, the Contractor shall submit a minimum of three (3) sets of the graphic displays, trend displays, and periodic reports for review by the Engineer and Owner.

b. A minimum of three (3) sets of submittals shall be submitted for review by the Engineer and the Owner. This submittal shall be prepared and submitted 30 calendar days after the requisite Graphics and Report Meetings specified in Section 40 95 20 – PLC-Based Control System Software.

2. Submittal Contents:

a. The Contractor shall refer to the specified Graphic meetings No.1 and 2 in Section 40 95 20 - PLC-Based Control System Software.

b. Displays: All workstation displays (graphics and trends) submittals shall be in full color as they will appear on the monitor. Locations for process data shall be clearly identified either through the use of simulated data or by showing variables on the displays and providing a reference list describing those variables. All dynamic points shall be identified by tag number as a minimum, and their operation shall be described on separate sheets (color change, symbol change, etc.).

c. Reports: Sample reports of each type shall be submitted in the format established in the Graphics Meeting. The reports shall use simulated data.

J. Factory Test Procedure Submittal:

1. Submittal Schedule: The Contractor shall submit for approval a comprehensive factory acceptance test (FAT) procedure **complete within 180 calendar days** after the date of Notice to Proceed is given to the Contractor, but not later than **60 calendar days** prior to the Factory Acceptance Test date.

2. Submittal Contents:

a. The Contractor shall develop and submit a factory test procedures to show that the integrated system hardware and software is fully operational and in compliance with the requirements of the Contract Documents. (Also see

"Quality Assurance" paragraph in this Section and Section 40 95 20 – PLC-Based Control System Software.

b. The FAT procedures shall include the following tests to be conducted:

1) Hardware review and inventory

2) Central computer system(s) start-up

3) Security

4) Navigation and operator's commands

5) Database definition and configuration

6) Graphic displays and editing function

7) Monitoring and alarm features and functions

8) Trending functions

9) Reports and report system functions

10) Network Communication and access from all the network nodes

11) Remote access from laptops

12) PLC functionality – I/O processing

13) Site/facility/Process PLC and HMI operation including pump and valve control

c. Procedure Format: The test procedure shall have a table of contents, and each procedure shall be provided on a separate sheet or sheets. The following shall be provided for each procedure:

1) Test number

2) The purpose of the test

3) The procedure

4) The expected result

5) Space to indicate "Pass" and "Fail" and explanation

6) Space for sign-off Signature for the Contractor/System Supplier, the Engineer, the Owner, and DATE

7) Space to provide comments and punch list items

K. Startup and Commissioning Submittals

1. Submittal Schedule: The Contractor shall submit for approval a proposed procedure to be followed during startup and commissioning of the PCIS and its components **complete within 270 calendar days** after the date of Notice to Proceed is given to the Contractor, but not later than **60 calendar days** prior to the Factory Acceptance Test date. The Contractor shall submit the proposal.

2. Preliminary Submittal: Outlines of the specific procedures and examples of proposed forms and checklists.

3. Detailed Submittal: After approval of the Preliminary Submittal, the Contractor shall submit the proposed detailed procedures, forms, and checklists. This submittal shall include a statement of objectives with the test procedures.

L. Training Plan and Training Manual Submittals:

1. Submittal Schedule: The Contractor shall submit for approval a training plan and a training manual submittal **complete and within 270 calendar days** after the date of Notice to Proceed is given to the Contractor, but no later than **60 calendar days** prior to start of the first training session.

2. Submittal Contents: The Training submittal shall consist of two parts:

a. Training Plan, which shall include:

1) Schedule of training courses including dates, durations, and locations of each class. Number of times each class will be offered, if applicable, and the number of people expected in each class.

2) List of courses and lessons and who will conduct them

3) Resumes of the instructors who will actually conduct the training classes. The Contractor shall identify in the submittal the courses and lessons that will be performed by the equipment manufacturer.

4) List of material used for the training, which shall include the Technical Manuals for the PCIS.

b. Training Manual

1) Training subjects' syllabus and associated lesson plans. The training subjects are listed in Part 3 "Execution" of this Section. If, in the opinion of the System Supplier, additional subjects that are not listed and are pertinent to the training and will benefit the Owner's staff, these subjects shall also be included in the training manuals and taught in the class.

1.6 CLOSEOUT SUBMITTALS

A. Technical Manuals Submittal

1. Submittal Schedule:

a. The Contractor shall submit for approval Technical Manuals for the PCIS: Initial set shall be submitted **complete and within 270 days months** after the date of Notice to Proceed is given to the Contractor. But at least **60 days** prior to the start of the Owner's training.

b. Each set shall consist of one (1) or more volumes and provided in PDF on a USB drive. In addition, a hard copy of the technical manual shall be provided in bound standard size, 3-ring, loose-leaf, vinyl plastic hard cover binders, suitable for bookshelf storage. Binder ring size shall not exceed 3 inches.

2. Submittal Contents:

a. Information in the Technical Manual shall be based upon the approved Shop Drawing submittals as modified for conditions encountered in the field during the WORK. The Technical Manuals shall therefore contain the as-built drawings and information.

b. The Technical Manuals shall include installation, connection, operating, calibration, set points (e.g., pressure, pump control, time delays, etc.) adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.

c. The Manuals shall have the following material organized in volumes and divided by subject and tabs. The Technical Manual shall have the following organization for each process (the number and the enumeration of the sections shall be project specific):

1) Section A - Process and Instrumentation Diagrams (as built copy)

2) Section B - System Architecture and Communication System Block Diagram(s)

3) Section C - Wiring Diagrams. A separate set of drawings shall be provided for each site. Each set shall be arranged in a separate tab (drawings shall also be provided in PDF).

4) Section D – Functional design report. It shall include a copy of the site's graphic display(s) and description of how the site is controlled and any special control strategies specific for each site. Special control functions in the server shall also be included. Calibration, set points (e.g., pressure, pump control, time delays, etc.) shall also be included.

5) Section E - Instrument Data Sheets and corresponding manufacturer's data sheet/catalog cuts/brochure that was used in the hardware submittal and the operation and maintenance/user manual.

6) Section F - Calibration Documentation

7) Section H - Loop, Commissioning and Performance Test Results

d. System User Manual: Its purpose is to provide an operator with a manual on how to use the SCADA system hardware and software and the HMI. The user manual shall be a separate binder and, as a minimum, shall include, but not limited to:

1) System Architecture Diagram with names and locations of major components

2) System access assignment procedures and security level assignment and their privileges and limitations

3) Navigation Bar/Buttons instructions (alarms, navigation buttons, maps, username, login procedure, site summary, communication, etc.)

4) Menus

5) Description of Graphic Standards Used (colors, symbols, etc.)

6) List of display screens, trends, and reports, with display name and description.

7) Procedures during system start-up, fail-over, and recovery

8) A list of the control screens with the display names and descriptions. It shall also provide a summary of possible commands and operator inputs to these screens, including set points. All control actions shall be included

9) Alarms: screen, maintenance, historical, messages, operator commands, etc.

10) Report data format and scheduling; procedures to change formats and scheduling. Instructions for manual printing screens or reports, both real-time and historical, as applicable.

11) Procedure to manually backup HMI software application and data files.

e. Software Manual: This manual shall be devoted exclusively to the control system software and the PLC programming. In addition to the requirements specified in Section entitled Contractor Submittal, this manual shall contain complete documentation of the software programs provided, including listings, database (USB drives), communication protocol(s), annotated PLC programs, and all as necessary to maintain, troubleshoot, modify, or update the all the software systems such as application software and PLCs. It shall also include:

1) All program manuals and USB drives are supplied by the manufacturers with the standard software packages and the source code of all high-level program language which is specifically created by the Contractor for this project.

2) All PLC program and workstation configuration program files are stored on labeled USB drives. The PLC program and workstation configuration

files on USB drives shall also be updated as required if any changes or corrections are required in this programming prior to project completion.

1.7 QUALITY ASSURANCE

A. Factory Acceptance Tests (FAT):

1. Prior to shipment, the PCIS, including all panels, integrated SCADA system, PLCs, peripherals, communications equipment, etc. provided under this Division, shall be assembled, connected, and all software loaded for a full functional factory acceptance test (FAT) of the integrated system. Existing equipment is not required to be included in this test.

2. In preparation for the FAT, the Contractor shall check, troubleshoot, debug, and test the PCIS prior to arrival of the Engineer in order for the PCIS to be ready for the FAT, minimize testing time, and minimize re-testing during the visit. Similar testing shall be performed even if the Engineer chooses not to witness the FAT.

3. The Contractor shall allow the Engineer and Owner to inspect the PCIS and witness the functional testing of the system at the site of assembly and integration of the system.

4. A minimum of 21 Days notification shall be given to the Engineer prior to testing. No shipments shall be made without the Engineer's approval. A successful completion of the test is a prerequisite to the shipment of the system.

5. The factory test will be witnessed by the Engineer and the Owner. The Contractor shall pay and provide for travel, food, and lodging for all the test witnesses.

6. The factory acceptance test shall be conducted at the place where the system was engineered, fabricated, assembled, and programmed.

7. It is considered reasonable that once scheduled, the system will be ready for the test, and the test will be successfully completed in one session. If during the test, at the opinion of the Engineer and in accordance with the test procedure, the system is not ready for the test or has failed, and the Engineer and the Owner must extend their stay or leave and arrive at another date, the Owner reserves the right to withhold monies due to the Contractor to cover additional costs of the Engineer's time, travel, food, and lodging and associated project cost.

8. During the factory acceptance test, the Contractor's Project Manager, and software engineers (HMI application software and PLC programming) who worked on the PCIS shall be available on the premises where the test is being conducted for explanation, demonstration, or corrections.

9. After the successful completion of the test, the Engineer will generate a punch list. The list may include items that must be corrected or addressed prior to the shipment of the system, and/or items that must be corrected later in the field during installation and startup.

B. Field Tests: The Contractor’s attention is directed to the Article "EXECUTION" of this Section which delineates all the tests that are required to be performed in the field in order to demonstrate compliance with the Contract Documents.

C. The Contractor shall provide and assign to the Owner all user software and hardware licenses. Computer and software system shall be purchased on behalf of the Owner who shall also be designated as the licensee. Each software package shall be provided with a “Site License” or with as many licenses as a “Site License” includes (site is defined as the name of the Owner). The Contractor shall include in the bid price all license fees.

D. The Contractor shall provide the proper number of software licenses for all the servers, workstations, and laptops to provide concurrent and simultaneous user operation.

E. Prior to final acceptance of the PCIS System and related equipment, the Contractor shall propose and present in writing to the Owner a one-year maintenance contract and quotation which will become effective upon the expiration of the warranty. The maintenance contract is an option that the Owner may purchase from the System Supplier. The contract shall offer different maintenance, site visit and helpdesk with options each with its respective cost.

1.8 FIELD SITE CONDITIONS

A. The PCIS shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:

1. Water treatment facility

B. Site Equipment:

1. Ambient temperature range: -18° through 60° C

2. Thermal shock: 1.0° (1.8° F) per minute maximum

3. Relative humidity: 95 percent maximum non-condensing

1.9 WARRANTY

A. All parts, material labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall be borne by the Contractor under the guarantee specified in Division 1. Equipment, software, and materials that do not achieve their intended purpose shall be replaced by the Contractor to attain compliance, at no additional cost to the Owner.

B. The performance of the servers and workstations hardware shall be guaranteed (repair of parts and labor at the owner's site including travel expenses) for a period of three (3) years following the date of completion and formal acceptance of the work (next business day on-site service).

C. Software Upgrades: During the warrantee period, the Contractor shall furnish and install at no additional cost to the Owner any application software upgrades published

applicable to Owner’s applications and compatible with Owner’s hardware and operating system.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Standard and Current Technology: All PCIS hardware, software, materials, and equipment furnished under this contract shall be new, free from defects, and shall be standard products and technology produced by manufacturers regularly engaged in the manufacturer of these products. Meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the Shop Drawings unless otherwise required to match existing equipment.

The Contractor shall submit a Substitute Item Request Form in case of discontinued or upgraded product or other cases where changing technology requires changes in equipment or software.

B. Adverse Environmental Impact: No component of an instrumentation system shall contain liquid mercury.

C. Hardware Commonality and Modularity: Instruments which utilize a common measurement principle shall be furnished by a single manufacturer. Panel mounted instruments shall have matching style and general appearance. Instruments performing similar functions shall be of the same type, model, or class, and shall be from a single manufacturer. All equipment shall be of modular design to facilitate interchangeability of parts to ensure ease of servicing and expandability.

D. Instrument and Loop Power: Power requirements and input/output connections for components shall be verified. Power for transmitted signals shall, in general, originate in and be supplied by the control panel devices. The use of "2 wire" transmitters is preferred, and use of "4 wire" transmitters shall be minimized. Individual loop or redundant power supplies shall be provided as specified and/or as required by the manufacturer's instrument load characteristics to ensure sufficient power to each loop component. Power supplies shall be mounted within control panels or in the field at the point of application.

E. Loop Isolators and Converters: The Contractor is responsible to resolve any signal level incompatibilities where required.

F. Signal Levels: Analog measurements and control signals shall be as indicated herein, and unless otherwise indicated, shall vary in direct linear proportion to the measured variable. Electrical signals outside control panels shall be 4 to 20 milliamperes DC except as indicated. Signals within enclosures may be 1 to 5 volts DC. Electric signals shall be electrically or optically isolated from other signals. Pneumatic signals shall be 3 to 15 psig with 3 psig equal to 0 percent and 15 psig equal to 100 percent.

G. Alternative Equipment and Methods: Equipment or methods requiring redesign of any project details are not acceptable without prior written approval of the Engineer through

the "or equal" process of The Bid Forms. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage, and maintenance enhancement over the equipment or method indicated, or shall include evidence that an indicated component is not available.

PART 3 -- EXECUTION

3.1 EXAMINATION

A. Shipping: After completion of shop assembly, factory test, and approval, the tested PCIS equipment, cabinets, panels, and computer hardware shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the Site.

B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the manufacturer shall be securely attached to each piece of equipment prior to packaging and shipment.

C. Tagging: A permanent stainless steel or other non-corrosive material tag marked with the instrument or equipment tag number shall be provided on each piece of equipment in the PCIS. Identification shall be prominently displayed on the outside of the package.

D. Storage: It is the Contractor’s responsibility to assure proper handling and on-site storage of instrumentation and control equipment in accordance with the System Supplier's recommendations. All equipment and materials delivered to the jobsite shall be stored in a location which will not interfere with the operations of other contractors or the Owner. Equipment shall not be stored outdoors. Storage and handling will be performed in manners which will afford maximum protection to the equipment and materials.

E. Equipment shall be stored in dry shelters, including in-line equipment, and shall be adequately protected against mechanical damage. If any apparatus has been damaged, such damage shall be repaired by the Contractor. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the Engineer. If such tests reveal defects, the equipment shall be replaced.

3.2 INSTALLATION

A. General

1. All systems and instrumentation, including instrumentation furnished under other Divisions, shall be installed, connected, calibrated, tested, started, and placed into operation in accordance with Contractor documents under Division 40 and the manufacturers' instructions. The installation shall be coordinated with the Engineer and the Owner. This shall include final integration in concert with equipment specified and provided by others.

2. The Contractor shall employ installers who are skilled and experienced in the installation and connection of all PCIS equipment.

3. The Contractor shall furnish the services of an on-site engineer to supervise and coordinate installation, adjustment, testing, and start-up of the PCIS. The engineer shall be present during the total period required to affect a complete operating system. A team of engineering personnel shall be at the site for 80 hours to check equipment, perform the tests indicated in this Section, and furnish startup services.

4. Equipment Locations: The monitoring and control system configurations indicated in the contract documents are diagrammatic. The locations of equipment are approximate unless dimensioned. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. Equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the Owner exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Contractor shall make such changes without additional cost to the Owner.

5. The Contractor shall review the existing site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

6. The Contract Documents identify conduits and instruments required to make a complete PCIS. The Contractor shall be responsible for providing any reasonable additional or different type connections as required by parts of the PCIS' specific installation requirements, or as practical.

B. Conduit, Cables, and Field Wiring

1. Conduits, process equipment control wiring, 4 to 20 mA signal circuits, signal wiring to field instruments and to control panels, PLC input and output wiring, and other field wiring and cables shall be provided under Division 26 and without delay to the WORK of Division 40.

2. PLC equipment cables, communication networks shall be provided under Division 40, but the installation in the field shall be under Division 26.

3. Terminations and wire identification inside PCIS equipment and panels furnished under this, or any other Division shall be provided under Division 40.

4. The Contractor shall supervise, and coordinate installation and termination and identification of field signals, power, and utilities associated with the PCIS. Resolve signal, power, or functional incompatibilities between the PCIS and new and existing interfacing devices.

C. Installation and Connections:

1. Instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements applicable to the Site. Appropriate mounting

stands and bracket materials and workmanship shall be provided and shall comply with requirements of the Contract Documents.

2. Existing Instruments that are to be removed and reinstalled shall be cleaned, reconditioned, and recalibrated by an authorized service facility of the instrument manufacturer. The Contractor shall provide certification of this WORK prior to reinstallation of each instrument.

3. The Contract Documents show the necessary conduit and instruments required to make a complete instrumentation. The Contractor shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements. Such additions and such changes, including the proposed method of installation, shall be submitted to the Engineer for approval prior to commencing that WORK. Such changes shall not be a basis of claims for extra WORK or delay.

4. Field Connection Panels and Interface Terminal Blocks: In cases where field I/O wiring has to be extended to a control panel or from enclosures or devices that are removed, the Contractor shall provide separate enclosures or junction boxes with interface terminal blocks that will serve as a field connection panel (FCP). The FCP and the terminal block shall be shown on the project-wide wiring diagrams.

5. Conduits and/or raceways in building interior locations shall be surface mounted on walls or ceilings wherever possible and run perpendicularly and parallel to building lines. Conduits shall not be routed on floors in areas subject to foot traffic. In exterior locations conduit shall be routed below grade.

6. Wires and cables shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the Engineer. Wiring shall be protected from sharp edges and corners.

7. Signal and low voltage wiring shall be run in a separate conduit from power and 120-volt control wiring.

8. Field wiring shall terminate at terminal blocks in the control panel. Field wiring shall not be wired directly to equipment in the control panel except for communication and specialty cables that must be wired directly to their respective equipment.

9. Power and signal wires shall be terminated with crimped type lugs.

10. Wires shall be marked clearly with an identification wire number labels that are of a permanent nature. Computer system equipment cables shall be identified and marked for their location at each end of the cable. Computers and peripheral equipment connections/ports shall also be identified as to what cable is connected to its port location.

11. Connectors shall be, as a minimum, watertight.

12. Sensing Lines and Tubing:

a. Instrument process sensing lines shall be installed in conduit under Section 26 00 00 - Electrical General Provisions and in a manner similar to the conduits. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3 feet of rigid tubing.

b. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at panels requiring pipe or tubing entries.

13. Flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.

14. Differential pressure elements shall have 3 valve manifolds.

15. The Contractor shall verify the correctness of each installation, including the polarity of electric power and signal connections. The Contractor shall certify in writing all discrepancies that have been corrected for each loop or system checked out. In addition, the Contractor shall make sure process connections are free of leaks.

3.3 FIELD QUALITY CONTROL

A. General:

1. Devices provided under Division 40 shall be initially calibrated by the manufacturer at the manufacturer’s facility prior to shipment. Following installation, the devices shall be field calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.

2. Each instrument shall be field tested, inspected, and adjusted to the indicated performance requirement in accordance with its manufacturer's specifications and instructions. Any instrument which fails to meet any contract requirement, or, in the absence of a contract requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the Engineer.

B. Calibration Points: During bench and field calibration each instrument shall be calibrated at least at 0, 25, 50, 75, and 100 percent of span using test instruments to simulate inputs and outputs. The test instruments shall have accuracies traceable to the National Institute of Standards and Testing.

C. Bench Calibration: Instruments that have been bench-calibrated by the manufacturer shall be verified in the field after installation to determine whether any of the calibrations are in need of adjustment.

D. Field Calibration: Instruments which were not bench-calibrated shall be calibrated in the field to ensure proper operation in accordance with the instrument loop diagrams or specification data sheets.

E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. Samples and sample gases shall be furnished by the manufacturers.

F. Calibration Sheets: Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:

1. Project name
2. Loop number and site or process name and number
3. Tag number
4. Manufacturer
5. Model number
6. Serial number
7. Calibration range
8. Calibration data: Input, output, and error at 0 percent, 50 percent, and 100 percent of span
9. Switch setting, contact action, and dead-band for discrete elements
10. Space for comments
11. Space for sign-off by System Supplier and when applicable by the manufacturer and date
12. Test equipment used and associated serial numbers

G. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the Engineer. The Contractor shall have the System Supplier sign the calibration sheet when calibration is complete. The Engineer will sign the calibration sheet when the calibration and testing has been accepted.

H. Loop Testing: The Contractor shall test newly installed loops for continuity and functionality. The up-to-date wiring diagrams shall be used as reference.

I. The Contractor shall notify the Engineer of scheduled tests minimum of 30 calendar days prior to the estimated completion date of installation and wiring of the PCIS. After the Engineer’s review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop testing shall be witnessed by the Engineer and/or the Owner.

J. Control Valve Tests: Control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to

verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to ensure that no changes have occurred since the bench calibration.

K. Interlocks: Hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers, and packaged equipment controls shall be checked to the maximum extent possible.

L. Loop Validation:

1. Control loops shall be checked under simulated operating conditions by input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the HMI displays associated with the PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested.

2. Accuracy tolerances for each analog network are defined as the root-mean-square (RMS) summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by contract requirements or by published manufacturer accuracy specifications, whenever contract accuracy requirements are not indicated. Each analog loop shall be tested by applying simulated analog or discrete inputs to the first element of an analog loop. For loops which incorporate analog elements, simulated sensor inputs corresponding to 0, 25, 50, 75, and 100 percent of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated RMS summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. Analog loop test data, including calculated RMS summation system accuracy tolerance, shall be documented by the Contractor on the loop validation sheets. The validation sheets shall be included in the O&M Manuals.

M. Loop Validation and Certification Sheets:

1. Loop Validation: The Contractor shall prepare loop validation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop validation sheets shall form the basis for operational tests and documentation. Each loop validation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the System Supplier as each loop is demonstrated to the Engineer/Owner that a loop is functioning during Loop Verification:

a. Project name

b. Loop number

c. Tag number, description, manufacturer, and model number for each element

d. Installation bulletin number

e. Specification sheet number

f. Loop description number

g. Adjustment check

h. Space for comments

i. Space for loop sign-off by the System Supplier and date

j. Space for Engineer witness signature and date

2. Loop Certification**:** A certified copy of each loop test validation sheet signed by the System Supplier, the Engineer or the Engineer's representative as a witness, with test data entered, shall be submitted to the Engineer together with a clear and unequivocal statement that the loops have been tested and the instrumentation in the loop has been successfully calibrated, inspected, and tested.

N. Manufacturer's Services

1. The Contractor shall provide jobsite visits and services of a manufacturer's technical field representative for supervision of the following:

a. Oversee installation: Supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as VFD, smart starters, pumps, valves, engines, and chemical feeders

b. Verify that installed instrument and software meet manufacturer's recommendations

c. Certify installation and reconfirm manufacturer's accuracy statement

d. Oversee loop testing, prepare loop validation sheets, and certify loop testing

e. Certify when testing is completed.

f. Training the Owner's personnel

2. Manufacturer's services shall be furnished for the following equipment:

3.4 COMMISSIONING

A. General:

1. Pre-commissioning, which is defined in Section 01 75 00 – Equipment Testing and Plant Startup, is basically the demonstration of proper operation of every part in the PCIS with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible. All systems shall be exercised through field operational tests, as a complete PCIS in accordance with the approved test procedures and in the presence of the Contractor and/or the Owner.

2. Pre-commissioning shall commence after completion and acceptance of continuity tests, calibration tests and loop tests, loop verification, and inspections have demonstrated that the instrumentation and control system complies with contract requirements.

3. Pre-commissioning Procedures and Documentation: Pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the Engineer. Test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the Engineer, which include calculated tolerance limits for each step. Completion of system pre-commissioning and test activities shall be documented by a certified report, including test forms with test data entered, delivered to the Engineer with a clear and unequivocal statement that system pre-commissioning and test requirements have been satisfied. The results of the testing shall also include a punch list developed by the Engineer.

4. The burden of proof of conformance of the system to specified functions and performance is on the Contractor. Tests that fail to demonstrate the required operation shall be repeated in their entirety or continued after corrective action has been completed at the discretion of the Engineer.

5. The Contractor shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the Owner, wherever the Owner or Engineer has reasonable doubt or evidence of malfunction or poor performance appears.

6. The Contractor shall coordinate the scheduling of tests among all parties involved so that the tests may proceed without delays or disruption by uncompleted work. Field operational and functional testing must be successfully completed prior to the start of the 30-day final acceptance test.

B. Operational Validation:

1. Where feasible, system pre-commissioning activities shall include the use of the actual process to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, PLCs, control panels, and ancillary equipment shall be tested under startup and steady state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. Hardwired and software control circuit interlocks and alarms shall be operational.

2. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady state operation of final control elements running under the control of process controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any), and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

3. Pre-commissioning shall also include the testing of remote sites to verify compliance with all functional requirements and communication specified. The testing shall include manual and automatic control modes, fail-safe and backup control modes, and PLC interlocks and control strategies provided by the System Supplier.

C. Loop and Equipment Tuning: Controllers incorporating proportional, integral, and/or derivative control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 0, 25, 50, 75, and 100 percent of span and the results checked against indicated accuracy tolerances.

D. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on test forms as follows:

1. The validation form, which shall include:

a. Project name

b. Loop number

c. Loop and function description

d. Tag number, description, manufacturer, and data sheet number for each component.

e. Pre-Commissioning Certification - A statement certifying that the contract requirements have been met. It shall also include a listing of instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system testing must be provided in writing by the Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the General Conditions.

f. Space for sign-off and date by the Contractor, the System Supplier, and the Engineer.

E. As part of the commissioning, the entire PCIS shall operate continuously without failure for 30 consecutive days without failure (see test details below), thus extending its operation test longer than the commissioning period specified in Section 01 75 00 – Equipment Testing and Plant Startup.

3.5 STARTUP OPERATION

A. General: Startup is defined as testing, demonstrations, and other activities required to achieve Substantial Completion. Pre-commissioning and commissioning activities, manufacturer services, certifications of readiness for testing, and troubleshooting, checkout, and shakedown activities must be completed before startup activities begin.

B. When all equipment and systems have been assessed by the Contractor to have been successfully carried through complete operational and functional tests with not less than a minimum of simulation, and the Engineer concurs in this assessment, system startup by the Owner's operating personnel can follow.

C. Each facility, process, or site startup shall be performed in accordance with the approved test procedures.

D. Scheduling of startup shall be coordinated by the Contractor among all parties involved so that the tests may proceed without delays or disruption by uncompleted work. System startup and training and instruction of the Owner's personnel must be completed by a minimum of seven (7) days prior to the final acceptance test.

1. Troubleshooting and Corrections

a. The Contractor shall participate in all start-up activities. If problems occur, the Contractor and the System Supplier shall jointly participate in the diagnosis of wiring, control interface, hardware and software problems and correct deficiencies. The Contractor shall be responsible and bear all expenses to diagnose and correct all the deficiencies for work and equipment furnished under this Contract.

b. Existing Instruments, Wiring, and Interface: As specified above, prior to start of the WORK the Contractor shall request the Owner to demonstrate that all existing equipment and software that is to be reused or interfaced with in this project works properly for the intended function. Consequently, if during the calibration, testing or start up the Contractor and/or the System Supplier encounters problems with existing instruments, hardware, wiring, or software that have been demonstrated to work, the Contractor shall notify the Engineer and the Owner. In this case, the Contractor, the System Supplier, and the Owner's representative shall jointly participate in the diagnosis of the problem. The course of action on how to correct the deficiency shall be determined jointly by the Owner, the Engineer, and the Contractor/System Supplier. The Contractor shall be compensated for correcting the deficiencies or replacing the equipment.

c. If a problem is found to be a result of the Contractor's workmanship or equipment and work furnished under this Contract, the Contractor shall be responsible and bear the expenses for correcting the deficiencies.

3.6 FINAL ACCEPTANCE TEST

A. After the pre-commissioning, functional tests and startup have been completed, the Contractor shall submit a report/letter stating that Contract requirements have been met, and the PCIS is ready for the Final Acceptance Test.

B. The entire PCIS shall go through a final 30-day acceptance test. For the purpose of this Contract, the terms "Final Acceptance Test" and "Final Performance Test" are synonymous and are used interchangeably. The 30-day test must be successfully completed prior to the date of and as a condition to substantial completion of the entire project WORK. During the testing period, all system functions shall be exercised, and

any system interruption and accompanying component, subsystem, software, or program failure shall be logged for cause of failure, as well as time of occurrence and duration of each failure.

C. In addition to the requirements of Section 01 75 00 – Equipment Testing and Plant Startup, the Contractor shall furnish support staff as required to operate the system and to satisfy the repair or replacement requirements. The Contractor shall also provide a competent programmer on call during all normal working days and hours from the start of the acceptance test until final acceptance of the system. The on-call programmers shall be ready to respond within two hours of the notification of the problem.

D. Testing: The entire PCIS shall be tested and shall include, but not limited to, the field instrumentation, control and PLC panels and PLC programs, application SCADA software, graphics and trends, reports, and the control and monitoring functions. Each system function, e.g., status report-backs, alarms, logs, and displays shall be exercised several times at a minimum, and in a manner which approximates "normal" system operation. At least two displays and reports shall be generated during the test.

E. Failure During Testing: Failure of the system during the testing shall be considered as indicating that part of the PCIS does meet the requirements of the specifications, and corrective action shall be required before restarting the acceptance test.

Failures shall be classified as either major or minor as follows, and it is at the discretion of the Engineer how to classify the failure:

1. Minor Failure: A minor failure would be a small and non-critical component failure which can be corrected by the Owner’s operators. This occurrence shall be logged but shall not be reason enough for stopping the test and shall not be grounds for non-acceptance or –restart, provided that the function(s) can be provided by backup equipment and repairs can be made and equipment returned to service within one (1) working day.

   However, should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance and termination of the test.

2. Major Failure: A major failure shall be considered to have occurred when a major component of the PCIS, subsystem, communication, or program fault causes a halt in operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system. A major failure shall cause termination of the acceptance test. When the causes of a major failure have been corrected, a new acceptance test shall be started.

F. Technician Report: Each time a technician is required to respond to a malfunction in the PCIS he/she must complete a report which shall include details concerning the nature of the complaint or malfunction and the resulting repair action required and taken. If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report shall be required (logged as specified above). Each report shall be submitted within 24 hours to the Engineer or its representative, and the Owner.

3.7 CLOSEOUT ACTIVITIES

A. Training:

1. The Contractor shall train the Owner's personnel on the PCIS operation, maintenance, calibration, and repair of equipment provided under this Contract. The training shall be done by qualified instructors. The training courses shall be given onsite to a minimum of four (4) people of the Owner's personnel. All instructions, tools and training materials shall be provided by the Contractor.

2. These courses shall be designed to provide the operations, maintenance, and supervisory personnel with training in routine and preventive maintenance of all the PCIS including instrumentation, communication, PLCs software, and HMI. The training course shall include instructions on the use of all maintenance equipment and special tools provided under the contract.

3. Instructions: The training shall be performed by qualified instructors. The training shall be performed by qualified representatives of the equipment manufacturers and shall be specific to each piece of equipment.

4. Training Manuals and Material: The Contractor shall use the approved Training syllabus and Training Manuals to develop training material. The training material shall be designed to provide the operations, maintenance, and supervisory personnel with training in routine operation procedures, and preventive maintenance and troubleshooting of the PCIS, PLCs and the computer monitoring and control systems.

5. Schedule: Training shall be performed on-site during the calibration, loop, and functional testing of the PCIS prior to the 30-day Final Acceptance Test. The training sessions shall be scheduled a minimum of 3 weeks in advance of when the courses are to be initiated. The Engineer will review the course outline for suitability and provide comments that shall be incorporated. Due to availability and scheduling of the Owner's staff, the Contractor shall coordinate with the Owner on the schedule of the classes. The Owner reserves the right to videotape the training sessions for later use. Due to possible limited availability of the Owner's staff, the Contractor shall provide the number of identical courses/sessions of each of the following training courses as indicated, each up to four (4) people of the Owner's staff.

6. Training Subjects, Duration, and Agenda: The training shall include operation and maintenance procedures, troubleshooting with necessary test equipment, and changing set points, and calibration for that specific piece of equipment. During the course, hands-on experience with the system equipment shall be provided. Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the PCIS and the PLCs. Operator classes shall stress operational theory and use of the PCIS and the PLCs.

    a. Field Instruments

        1) Duration – an average of two (2) hours per each type of instrument

2) Subjects - installation, setup, configuration, maintenance, calibration, and troubleshooting:

a) Pressure transmitter

b) Level transmitter

c) Flow measuring device and transmitter

d) Analyzer – liquid and gas

e) Power monitoring equipment

f) Uninterruptible power supply (UPS)

7. PLC: The training of the following subject shall be performed by the Contractor and the PLC manufacturer as noted: Maintenance classes shall stress troubleshooting, repair, calibration, and other technical aspects of the PLC. Operator classes shall stress operational theory and use of the PLCs.

a. Duration –40 instruction hours or a minimum of 8-hours per class of PLC training.

b. Subjects:

1) PLC System Hardware and Programming Software - General Familiarity – by the PLC Manufacture.

2) PLC programming, I/O, ladder logic, registers, etc. (process/site specific) – by the Contractor

3) Project specific operation and communication – by the Contractor

4) Project specific PLC program troubleshooting – by the Contractor

5) PLC Hardware- Troubleshooting and Repair of PLCs _by the PLC manufacturer or by the Contractor if approved by the Engineer

8. Central computer system and HMI Development

a. Duration

1) 8 hours for maintenance programmer

2) 8 hours for development training system

b. Subjects

1) HMI configuration.

2) Report and trend generation

3) Operator training

4) Programmer training

5) HMI graphics with emphasis on making changes and additions to reports and displays method to be used for scheduling and changing the scheduling of reports.

6) Data base programming, adding, or deleting analog and digital points adding future data base points. linking data base points to screen displays

7) The Contractor shall provide two (2) identical courses/sessions of development system training. Each development training system training course shall be 16 hours for graphic displays and report generation applications.

8) Integrating future PLCs into the SCADA system

9) Historical backup and maintenance.

10) Server redundancy, failure, and switchover

11) Diagnostics, troubleshooting, and related procedures

9. Communication System and Network

a. Duration –8 hours

b. Subjects –

1) PLC communication hardware

2) Network equipment and maintenance

3) Communication protocols

4) Communication failure diagnosis/troubleshooting and repair

3.8 CRITERIA FOR SUBSTANTIAL COMPLETION

A. For the purpose of this Section and all Division 40, the following conditions shall be fulfilled before the WORK is considered substantially complete:

1. Submittals have been completed and approved.

2. The PCIS has been calibrated; loop tested, pre-commissioned, commissioned, and the startup completed.

3. The Owner’s training has been performed.

4. Spare parts and expendable supplies and test equipment have been delivered to the Owner.

5. The Final Acceptance Test has been successfully completed.

6. Major punch-list items have been corrected.

7. As built drawings have been submitted. The as-built drawings shall also include annotation of the PLC ladder logic program by providing a descriptive label for all relays and function blocks and functional description of each rung.

8. Revisions to the Technical Manuals that may have resulted from the field tests have been made and reviewed.

9. Debris associated with installation of instrumentation has been removed.

10. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

END OF SECTION

SECTION 40 91 20 – SAFETY MONITORING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The CONTRACTOR shall provide all safety monitoring systems, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Section 40 91 00 - Process Control and Instrumentation Systems.

C. Applicable Sections in Division 40 – Instrumentation and Control for Process Systems.

D. Division 26 – Electrical.

PART 2 -- PRODUCTS

2.1 COMBUSTIBLE GAS DETECTION AND MONITORING SYSTEMS

A. The combustible gas monitoring system shall continuously detect and monitor the lower explosive limit (LEL) concentration of hydrogen-based combustible gases or vapors in ambient air of the environment it is installed, using infrared measurement technology.

B. Consideration shall be taken for sensing gases that are lighter or heavier than air and for the intended service and installation of application of the monitoring system. Therefore, the combustible gas sensor and transmitter shall be available as follows:

1. Either as an integral unit, or

2. As separate units capable of remote sensing application, installation requires the sensor to be separated from and mounted remotely from its electronics. The maximum distance between the sensor and the transmitter shall be as recommended by the manufacturer.

C. Sensor

1. The sensor model for monitoring the LEL of a specific gas shall be selected in accordance with the intended service application as recommended by the manufacturer and as indicated in a list of the data sheet. Sensors for different gases shall be able to be interchanged with each other and calibrated accordingly.

2. The sensor shall be capable of operating in high-gas and oxygen-deficient environments. The monitoring range shall be 0-100% LEL of hydrogen-based gases. The combustible gas detection and monitoring system shall have field-selectable algorithms for monitoring a variety of hydrogen-based gases. The specific gases that are monitored shall be as indicated in the data sheet.

3. The sensor shall be contained in a sensor module, which shall contain the sensor information and parameters.

4. The sensor shall be automatically temperature compensated, and suitable for use in a relative humidity range of 5 to 95%. The sensor shall not use any consumables.

D. Transmitter

1. The transmitter shall produce an isolated 4-20 mA output into a load of at least 500 ohms. The signal shall be proportional to the LEL concentration.

2. Accuracy shall be +/- 2% full scale. Repeatability shall be +/-1% of full scale. Response time shall be less than 2 seconds.

3. Signal resolution shall be at least 0.1%, and linearity shall be at least 99% throughout the measured range. Zero drift shall be eliminated by automatic digital zeroing.

4. An LCD digital indicator shall be an integral part of the sensor/transmitter enclosure. The indicator shall be scaled in percent and alternate between displaying the gas type being monitored and the concentration of the gas present.

5. The transmitter shall be provided with LED/relays to indicate field programmable alarm conditions (3 relays) and fault (one relay). Relay contacts shall be rated 5-amps. The transmitter shall provide continuous internal diagnostics with locally displayed error messages and an instrument error relay output.

E. Sensor and transmitter enclosure materials shall be corrosion resistant (minimum 316 stainless steel) and suitable for wall mounting. As a minimum, the sensor/transmitter shall be rated and suitable for installation in Class I, Div. 1 or 2, Groups C, D environment and as recommended by the manufacturer for the intended installation application and as indicated in the data sheet.

F. The sensor and transmitter shall be provided with mounting hardware appropriate for the intended installation location as recommended by the manufacturer and as indicated in the data sheet.

G. Accessories: The combustible gas monitoring units shall be provided with the following accessories made by the same manufacturer as the monitoring unit.

1. A non-intrusive universal electronic calibrator module. Only one module is required regardless if one or more gas monitoring systems are provided.

2. A calibration kit with flow control regulator, connection tubing, and fittings. Only one calibration kit is required regardless if one or more gas monitoring systems are provided.

3. Calibration cylinders with zero and span gases sufficient for one year of calibration for each type of gas being monitored.

H. The combustible gas monitoring system manufacturers and models shall be **MSA Ultima- X-XP with XIR Infrared combustible (LEL) sensor and with calibration/test kit model A-CAL including calibration gases**, **or Draeger model Polytron**, or equal.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. Safety monitoring systems shall be handled, installed, calibrated, loop-tested, pre-commissioned, and performance tested in accordance with Section 40 91 00 - Process Control and Instrumentation Systems. Manufacturer's service, supervision, and training shall also be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 95 10 – PLC-BASED CONTROL SYSTEM HARDWARE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor, through the use of the System Supplier, shall provide the programmable logic controllers (PLC)-based control system (PBCS) hardware for the PCIS, complete and operable, in accordance with the Contract Documents. The PBCS shall be furnished complete with all system software as indicated in Section 40 95 20 – PLC-Based Control Systems Software.

B. The System Supplier shall be responsible for selecting, sizing, and providing the correct and necessary type and quantity of hardware for the entire PBCS and for each PLC. The necessary hardware and software shall include but not limited to servers, workstations, network hardware, PLC input/output (I/O) modules, interconnecting cables, accessories, communication ports, adapters and cards, and all appurtenances for proper operation of the PBCS and to meet the functional requirements described in these specifications, and as shown on the system architecture diagram or network diagram. The System Supplier shall be responsible for the interface to existing systems or those furnished by others. The System Supplier shall also provide the latest version of software to enable the programming and integration of the PBCS.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. Section 40 91 00 - Process Control and Instrumentation Systems

B. Section 40 95 20 – PLC-Based Control System Software

C. Applicable Sections in Division 40 – Instrumentation and Control for Process Systems

D. Division 26 – Electrical

E. Division 27 - Communication

F. The PBCS equipment, materials, and other work shall conform to the specifications; codes and standards requirements specified in Section 40 91 00 - Process Control and Instrumentation Systems.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. The PLC submittal shall be provided in accordance with the requirements specified in Section 40 91 00 – Process Control and Instrumentation Systems.

1.4 CLOSEOUT SUBMITTALS

A. Software: The Contractor shall provide and register the Owner with all user software and hardware licenses. Additional contract, agreements, and licenses requirements shall be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

1.5 WARRANTY

A. The Contractor shall guarantee the performance of all the new PLCs and the programming software for them as specified elsewhere in the Contract Documents.

B. All parts, material labor, travel, subsistence, or other expenses incurred in providing services and service visits during the warranty period shall be borne by the Contractor under the guarantee. Equipment, software, and materials that do not achieve their intended purpose shall be replaced by the Contractor to attain compliance, at no additional cost to the Owner.

C. Guarantee and special corrections of defects and software upgrade requirements and warrantee shall be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Description:

1. The Contractor shall furnish all necessary hardware, software, interconnecting cables, all accessories, and all appurtenances as indicated herein or as required for proper operation of the PLC.

2. All PLC materials and equipment furnished for the PLC shall be standard off-the shelf commercially available products and shall be the product of a single manufacturer.

3. All components that are common to the PLCs shall be of the same manufacturer and family of PLCs. All the PLCs have the same components manufacturer (e.g., processor, memory, chassis style, I/O cards, etc.). Special minor interface hardware not provided by the PLC manufacturer can be a product by the manufacturer's approved third party.

4. The Contractor shall size each PLC in accordance with the I/O list.

B. Performance / Design Criteria:

1. Processor shall be a Rockwell Automation CompactLogix 5069 series processor, no substitutions.

2. The PLCs shall be designed and constructed for satisfactory operation and long, low maintenance service under the following environmental conditions:

    a. Ambient temperature range: 0°C through 60°C

    b. Thermal shock: 1.0° (1.8°F) per minute maximum

    c. Relative humidity: 95 percent maximum non-condensing

3. Construction: The PLC central processing unit (CPU) shall be a modular unit which shall contain the operating logic. . The input/output (I/O) modules shall also be modular and interface directly with the CPU through a back common panel or by a special cable if expansion is required. The PLC shall provide a means for mounting the chassis in a standard cabinet or 19-inch rack. The PLC shall be capable of operating in a hostile industrial environment (i.e., heat, electrical transients, RFI, vibration, etc.) without fans, air conditioning, or electrical filtering and be designed to provide high reliability specifically in this !

4. The PLC shall be of modular, field expandable design, allowing the system to be tailored to this process control application. The capability exists to allow for expansion of the system by the addition of hardware and/or user software. The PLC shall be provided with I/O (input/output) modules and with sufficient memory, power, and appropriate cables to be able to interface with new and existing field devices, necessary to function as a complete and operable PLC system.

5. Logic functions must be performed in a given application, which shall be programmed into the PLC memory. All equipment shall be capable of tolerating and capable of riding through a power interruption of 8 milliseconds or less without interruption of normal operation and communication.

6. It is the intent of these specifications to provide PLCs which can be easily expanded and configured. Therefore, all changes in system architecture, expansion of I/Os, modification to and implementation of control strategies shall be easily done on-site

7. The PLC shall be capable of communicating with remote I/O racks or other PLCs via fiber optic cable up to 10,000 cable feet from the processor without requiring additional communications hardware except for fiber-to-copper modules.

8. PLC Growth Provisions

    a. All equipment and resources, including PLC, I/O cards and implementation services, shall be provided such that project memory and I/O growth can be implemented into the PBCS without any additional cost to the Owner.

    b. CPU memory reserve capacity for project growth shall also 20 percent.

    c. The I/O points included in the 20 percent project I/O growth requirement shall be termed “implemented spare I/O” (wired to field terminals). The 20 percent implemented spare I/O is 20 percent of each type of the total project I/O listed and may be implemented in any one or more I/O cards and racks at the

direction of the Owner at any time throughout the duration of the project until the beginning of factory testing. Subsequent to factory testing, the unused implemented I/O, if any, shall be delivered to the Owner as spare I/O.

d. Implementable spare I/Os shall mean that each of these I/O shall also be wired to the field interface terminals.

e. Future and Spare Signal (i.e., the source of inputs or final control elements for DO and AO are not yet known or available in the field). The percentage of additional terminals for future signals (not implemented) shall be in accordance with the requirements specified in Section 26 05 15 – Industrial Control Panels.

f. Spare Empty I/O Module Slots: Each new PLC location shall be provided with empty I/O module slots.

9. Central Processor Unit

a. The central processor shall contain all the software relays, timers, counters, registers, sequencers, and arithmetic capability necessary to perform the specified control functions. It shall be sized to be capable of interfacing with sufficient discrete inputs and outputs, analog inputs, and outputs to meet the specified requirements plus the required project percent growth as specified above, or as required by the I/O list, whichever is greater. The CPU shall be a self-contained unit and shall provide control program execution and support remote or local programming. The PLCs shall be provided to support and implement closed loop floating and PID control which is directly integrated into the PLC program.

b. The CPU shall be furnished with a watchdog timer. The processor shall have a key type memory protect switch to prevent unauthorized program changes.

c. The CPU shall perform internal diagnostic checking within the system and give visual indication to the user when no fault is detected and when a fault is detected. If power to the CPU fails or gets disconnected, the processor shall cease operation, forcing all outputs off.

10. Memory

a. The PLC shall be supplied with sufficient memory to implement the specified control function plus a reserve capacity for project growth requirements as specified above. This reserve capacity shall be free from any system use.

b. A minimum of 32 Mbytes of RAM shall be furnished with each PLC. This memory is the total user's memory of programming and data and includes the spare capacity. This reserve capacity shall be free from any system use. RAM memory shall hold the specific configuration, measuring and control functions and constraints, set points, and real-time I/O data. Additional memory shall be furnished where necessary to accommodate the I/Os and functional requirements.

c. The memory shall be programmed in a multi-node configuration with multiple series or parallel contacts, counters, timers, and arithmetic functions.

d. It shall be possible to upgrade to a processor with a larger memory size simply by saving a program, replacing the processor, and downloading the program to the new system without having to make any program changes.

e. User memory in the processor not used for program storage shall be separated from main memory for the purpose of data storage.

f. Battery: The PLC memory shall have a battery backup or other means of backup. The programming memory shall be with sufficient backup to retain the program during power interruptions of up to 1 year. The capability shall exist to remove all batteries from the system without removing system power. An indicator shall show the status of the batteries (if used). A low battery condition must be detectable in ladder logic but shall not automatically generate a major fault.

C. Materials / Components

1. Communication Ports and Network Interface

    a. General: The PLC shall be able to communicate to the SCADA central computer system and/or other PLCs over a network and allow industry standard repeaters, bridges, routers, and gateways on the network in order to access other PLCs and host computers.

    b. Each PLC shall be furnished with the following multiple on-board Ethernet communication ports. Each Ethernet port shall have industry standard fast Ethernet TCP/IP communication capabilities to communicate over twisted pair cabling or fiber optic cable as applicable. Depending on the PLC manufacturer, additional modules as required, depending on the PLC manufacturer. (Third party adapters are acceptable):

        1) 100BASE-TX (IEEE 802.3u) – twisted pair

        2) 100BASE-FX – Fiber optic cable

        3) 1000BASE-T (802.3ab) – Twisted pair

        4) 1000BASE-X (802.3z)– Fiber optic cable

    c. A dedicated port for PLC programming shall be provided without the need to disconnect communication operations from one of the other ports. A USB port or serial port that supports RS-232-C, RS-422, and RS-423A signals shall be provided for that purpose, or for access to peripheral devices such as bar code scanners, etc.

2. Input / Output Modules

    a. General

        1) All I/O housings and I/O modules shall be suitable for hostile industrial environments as described above. All I/O modules shall be isolated and conform to IEEE Surge Withstand Standards and NEMA Noise Immunity Standards. Modules shall be removable without having to disconnect wiring from the module's terminals by means of a swing-arm or plug-in wiring connector. Sufficient input and output modules shall be provided at each PLC location to implement the specified control functions plus the required project percent growth and spare of I/O as specified above or as required by the I/O list, whichever is greater. The I/O modules shall be from the same manufacturer as the processor.

    b. Power input (see also paragraph “PLC Power Supply”):

        1) Provide 24 VDC power supplies for Mod and SA connections in the processor. Power supplies shall be sized for a minimum of 150% of maximum power required for each process and taking into account connected field circuit loads.

        2) The modules shall operate on an external 120 VAC power supply. The 24 VDC power shall be applied (“wet”) to the DI loops, and a 24 VDC shall be applied for 2-wire analog input loops.

3) In cases when the CPU must be powered by a 120 VAC power source due to existing conditions or Owner requirement, the module shall operate on a 120 VAC, 50/60 Hz power.

c. During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel. Any remote input/output channel shall be field selectable to shut down the CPU upon failure of that channel. Upon remote channel shutdown, the CPU shall see all inputs on the malfunctioning channel as they were when the shutdown occurred, and all outputs shall de-energize on that channel.

d. All internal logic and circuits shall be isolated from external power circuits. This isolation shall meet the minimum IEEE specification of 1500 VRMS.

e. Combination Modules – A Module that provides a combination of discrete inputs and outputs or analog inputs and outputs can be used as long as the I/O quantities meet the system requirements. The specification of each group if I/O must also meet the specification as if it is an individual type module.

3. Discrete Input Modules

a. Discrete (digital) input (DI) module shall accept DI signals, which is defined as a dry relay contact closure inputs signal from devices external to the PLC. The module shall accept a maximum of 32 inputs. PLC module Input modules shall be shielded from short time constant noise and 60-Hz pickup. Individual inputs shall be optically isolated for low energy common mode transients to 1500 volts peak from user's wiring or other I/O modules and shall have IEEE surge withstand protection. All inputs shall be isolated from each other. The modules shall have LED lights to indicate a discrete input. Input signal level shall be 24 VDC.

b. The module shall be capable of accepting normally open and normally close input contacts, and to change the input in the module through programming if the contact in the field changes from normally open contact to normally close.

4. Discrete Output Modules

a. Discrete (digital) output (DO) module shall produce contact closure output (DO) signals to interface or operate equipment and devices external to the PLC module. The output modules shall be optically isolated from inductively generated, normal mode and low energy, common mode transients to 1500 volts peak and shall have IEEE surge withstand protection. Output modules shall have LEDs to indicate the status of each output point. Each output point shall be individually isolated and fused.

b. The discrete output modules shall have a maximum of 8 points each. If required, each of the module’s output shall interface with an external and separately mounted relay (interpose relay) that shall provide the dry discrete contact output. The output relay shall have a single form-C contact (one normally open and one normally close contact) with a minimum contact rating of 10-amp, 120 VAC, or as required by the application. The failure of a single output relay shall require only the replacement of the relay and not the entire module. Failure of the module shall require the replacement of the module and not the relays. Relays shall be in

agreement with Section 40 67 00 - Control System Equipment Panels and Racks.

5. Analog Input Modules

    a. This module accepts 4 to 20 mAdc analog input signals. The module shall perform an analog to digital conversion where an analog to digital conversion is performed with 16-bit precision and the digital result is entered into the processor. New inputs shall be provided for every processor scan. The external 24 VDC power supply shall power the 4-20 mAdc 2-wire transmitters/ loops. Input modules shall be source or sink to accommodate 2-wire or 4-wire transmitters, respectively. Analog input modules shall have 4, 6 or 8 differential inputs each and shall be isolated from each other.

    b. Analog inputs module shall also be able to accept the following analog ranges:

        1) Voltage range: 0 to +5 VDC, +1 to +5 VDC, 0 to +10 VDC, -5 to +5VDC, -10 to +10 VDC.

        2) Current range: 4 to 20 mA, -20 to +20 mA.

6. Analog Output Modules

    a. This module shall provide for 4-20 mAdc analog signals output. Each analog output module shall have 4, 6, or 8 isolated output points which shall be rated for loads of up to 1200 ohms. The module shall perform a digital to analog conversion with each scan of the processor and the analog result produced as an output. New outputs shall be produced on every scan. Analog outputs shall be isolated in the same manner as the analog input modules.

7. Remote I/O Adapter Module: Any PLC location, which requires more than one housing unit to mount all of the I/O modules, shall be supplied with an appropriate remote I/O adapter module for each secondary housing. The adapter module shall support all of the types of I/O modules required.

8. PLC and I/O Housings: The PLC, power supply, and I/O modules shall be mounted in suitable standard housings. Individual housing slots shall be mechanically configurable to prevent insertion of incorrect modules. Each new PLC location shall have empty I/O module slots to accommodate the required project growth requirements as specified above. The PLC shall also be provided with all the necessary mounting hardware, connectors, and cables. Filler plates shall be provided for unused slots in the PLC rack.

9. PLC Power Supply

    a. The PLC, I/O Modules and the analog and digital loops shall be powered by a single main external source of redundant set of 24 VDC power supply system, The redundant power supplies shall be configured in a fault-tolerant manner in order to prevent interruption of service upon failure and interruption of utility power or service necessitated by the replacement of a power supply.

    b. The 24 VDC power supplies shall have 120 V, 60 Hz input, a 24 VDC linear output, with +/- 0.05% line and load regulation. Power supplies shall be designed for parallel wiring of the 24 VDC output. Power supplies shall be power factor correcting and shall have short circuit and overload protection. Each power supply shall be sized at twice the initial connected load including slave and interposing relays.

    c. The power supply shall include diagnostic indicators to provide the operator with the status of the DC power applied and the redundancy. Each 24 VDC power supply shall also include status and fault LED indicators and a fault/redundancy status monitoring dry contact output. The fault status output contact of each power supply shall be wired to its own PLC digital input (DI).

    d. In cases where the CPU must be powered by a 120 VAC power source due to existing conditions or Owner requirement, a 120 VAC 60 Hz power supply shall be provided and mounted in the PLC housing to power only the CPU and the I/O modules. It shall be sized to power the CPU and all modules mounted in that housing and an "average module load" for any empty housing slots plus the percent growth requirement specified above that total. The 120 VAC power supply shall be by the same manufacturer as the PLC and shall be of the same product line.

    e. In all cases, the analog and digital loops shall be powered by an external redundant 24 VDC power supplies as specified above.

    f. The power supply shall monitor the incoming AC line voltage for proper levels and shall automatically shut down the PLC system whenever its output current is detected to be at improper levels. Power supplies shall have fuse protection. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch or fuse.

10. PLC Control System Software and Programming

    a. General

1) The Contractor shall furnish the latest version, standard, field proven, fully debugged and supported PLC programming and diagnosis software package for this application with a minimum of additions or changes. Customized or specially written software shall be furnished if required to meet all of the functional requirements specified herein. Any custom applications software required shall be fully integrated into the basic software and shall not require unique command structures.

2) All programs shall be self-configuring, such that they obtain the size and configuration of the system from parameters contained in the various files created during system generation. No parameters related to the hardware configuration shall be hard coded into any of the software.

3) All programming, monitoring, searching, and editing shall be accomplished using this PLC programming software. The programming software shall be usable while on-line (connected to the PLC), or off-line. The PLC program shall display multiples of series and parallel contacts, coils, tuners, counters, and mathematical function blocks. It shall have the capability to disable/force all inputs, outputs, and coils to simulate the elements of the ladder logic by means of color change. The software shall include a search capability to locate any address or element and its program location PLC status information, such as error indication and amount of memory remaining shall be shown on the display screen.

4) The PLC programming software package shall be able to monitor and/or control PLCs via the communication network. It shall contain diagnostics to collect troubleshooting and performance data and display it in easy-to-understand graphs and tables. It shall also monitor devices at each drop on the communication link for proper communication.

5) The PLC programming software shall be able to generate a PLC program printout which is fully documented. Fully documented program listings shall have appropriate rungs, addresses, and coils shown with labels, descriptors, and identifiers. Comments shall clarify to a reader what each segment of the program accomplishes. A fully documented listing shall also include a cross-reference report of program addresses.

6) The PLC programming software shall run on Windows platform. The programming language and format shall be IEC 61131-3 compliant and allow programming to use Ladder Diagram (LD), Sequential Function Chart (SFC), Functional Block Diagram (FBD) programming languages.

7) The PLC shall be easily programmed with a laptop plugged into the controller. Programming functions shall be done both “on-line” while the processor is scanning, or “off-line.” On-line programming and upload/downloads of control programs shall be able to be done over the Ethernet network.

8) Furnish a minimum of 3-user licensed copies of the PLC programming software registered to the Owner. The software shall be provided with all the options the necessary option to meet the requirements in these specifications.

2.2 OPERATOR INTERFACE TERMINAL (OIT)

A. Manufacturers: The PLC and the OIT specified herein shall be of the same manufacturer by Rockwell model PanelView Plus series or equal.

B. Description: The Contractor shall furnish an Operator Interface units (OI's) and software for each PLC or as indicated on the drawings with the following features:

C. Materials / Components:

1. 12 inch (minimum) active-matrix color TFT LCD monitor with touch screen controls. Resolution shall be standard SVGA (min 800x600 pixels) with 65,356 color graphics.

2. Ports: Ethernet (IEEE802.3, 10/100 BASE-T), 2- USB, RS-232, RS 485

3. Protocol Supported – Modbus TCP/IP, Modbus (serial),

4. Memory – 32 MB flash EPROM, 512 Kb SRAM with battery backup, and slot for memory card.

5. Power – 24 VDC

6. UL Listed., NEMA 4X (indoor and outdoor application)

7. Memory Card 128 MB

8. Configuration and development software running on Windows with password protection.

9. Software and Configuration - The OIT shall be configured to display simple graphics that include facility graphics similar to those displayed on the HMI. The OIT shall enable access to change operational set points in the PLC for the operator access. Additionally, the OIT shall display process variables trending, and display/manage facility alarms. The software shall be of the same manufacturer as the OIT.

2.3 HUMAN MACHINE INTERFACE (HMI) HARDWARE

A. Description:

1. The contract documents shall present the various HMI node types required for the HMI system. A summary description of each node is provided below and in Section 40 95 20 – PLC-Based Control System Software.

2. This Section covers the furnishing of standard HMI hardware fully installed and configured in the control system as specified herein. It is the intent of this Specification to have the Contractor furnish the latest standard, field proven, and supported PLC-based hardware for the PCIS.

3. All computer hardware shall be furnished with all necessary power supplies, processors, main memory, auxiliary and bulk memories and their corresponding drives, peripheral interface cards, auxiliary function cards, modems, cables, drivers, etc., to meet the functional requirements for the configured system as specified and as shown on the system architecture diagram.

4. All numeric specifications below (i.e., processor and speed, hard disk size, amount of RAM, etc.) are minimum values only. The Contractor shall propose equipment with higher performance specifications than those specified as new technology develops, is available and allows. Such proposals should be made to the Owner and the Engineer at the pre-submittal/pre-construction meeting. The proposed equipment shall be field proven.

B. Materials / Components:

1. Dedicated Operator Workstation

a. Machine Type: Fan-less, disk-less industrial operator interface.

b. Operating System: MS Windows CE, ME, or Pro platform.

c. Specifications and Features: As recommended by the HMI application manufacturer to support the required control screens and I/O density.

2. Full Client Workstation

a. Machine Type: Desktop single-processor, single-drive, graphic workstation grade computer.

b. Operating System: MS Windows Pro platform.

c. Specifications and Features: As recommended by the HMI application manufacturer to support the required control screens and I/O density.

2.4 SERVER COMPUTERS

A. General

1. HMI servers provided shall be rack mounted server class computer systems. All server computer systems and related hardware shall be as specified in these specifications, or the equivalent ENGINEER OF RECORD approved platform at time of order.

2. Provide HMI server computers as shown on the drawings. Server computers shall include, as a minimum, systems shown as backup to SCADA server.

B. Technical Requirements

1. Provided HMI servers with the latest version of Microsoft Windows Server 2022 with the latest service packs approved for installation by the OWNER.

2. Server computers shall be the4 latest Cisco Hyperconverged X series, M7+ (or most recent version compatible with the SCADA environment operating system), or ENGINEER OF RECORD approved equivalent at time of ordering. Servers shall include all hardware required for 19" rack mounting and occupy a 2U rack space.

3. Monitors associated with servers shall be rack mounted fold-out 17" monitors. Keyboards and pointing devices shall be a draw-out type designed for mounting in a standard 19" equipment rack. Provide monitors and keyboards, as shown on the Drawings.

4. Server computers shall include the following options at a minimum:

   a. Virtual Environment

      Host Infrastructure:

      Host infrastructure will be on current Cisco Hyperconverged X series technology.

      System Requirements:

      - **Server Type**: M7+ or latest version of Hyperconverged X series available with 3 nodes minimum for high availability/redundancy with Fabric interconnect 6536 or better. Rail Kits must be included.
      - **Operating System**: Nutanix
      - **Warranty Support**: Minimum of 3 years 24x7 support
      - **CPU Requirements**: Minimum of 2 Intel® Xeon® Gold 6554P Processors per node unless higher specifications are required. AMD based server processor substation may be allowed if performance is superior to specified Intel Xeon.
      - **RAM Requirements**: Minimum of 512 GB of ram per node
      - **Power Requirements**:
        Minimum of Dual 1200W Titanium power supplies per node.
      - **Storage**:
        - Minimum of 10 TB of usable storage using Nutanix Distributed Storage Fabric
        - Separate raid 1 boot drive or equivalent required for hypervisor with a minimum drive size of 240gb
        - NVMe or SSD storage for performance/reliability is required.

    - Total storage space requirements, along with the expected data retention period, must be specified based on anticipated usage.
    - If the expected storage growth rate exceeds the original request, it must be disclosed and agreed upon by Valley Water in advance.
- **Network**:
    - Requires capability of 10/25gb, 40/100gb connectivity.
    - Must utilize 40/100gb connectivity to connect FI to nodes using redundant pathing.
    - All connectivity to the hardware must be setup in a High Availability/redundant configuration

Virtual Machines:

- **Operating System**: Windows Server 2022 Standard.
- **Database (If Required)**:
    - Database will be built in a High Availability (H/A) configuration.
    - Latest supported version of Microsoft SQL Standard highly preferred.
    - Equivalent and embedded options will be considered.
    - Database H/A functionality must allow for updates and patches at any time.
    - Database licensing must be provided by the vendor and support migration between hosts within the virtualized environment.
- **CPU Allocation**:
    - Minimum of 4 vCPUs for standard servers.
    - Minimum of 6 vCPUs for database servers unless higher specifications are required.
- **RAM Allocation**:
    - Minimum of 16 GB for standard servers.
    - Minimum of 64 GB for database servers unless higher specifications are required.

- **Storage**:
    - High-performance network storage for VMs within the virtualized environment using flash-based storage.
    - Total storage space requirements, along with the expected data retention period, must be specified based on anticipated usage.
    - If the expected storage growth rate exceeds the original request, it must be disclosed and agreed upon by Valley Water in advance.
    - NVMe or SSD storage for performance.
- **Network**:
    - Virtual 10 Gbps NICs for high-speed connectivity.
    - VLAN configurations as required

5. Security

    a. Access Control

        1) Role-based access with Active Directory integration

    b. Encryption

        1) TLS 1.3 for data transmission

        2) AES-256 fort storage encryption

    c. Firewall

        1) Software-based firewall enabled on all machines with appropriate firewall rules for access setup

6. Application Software

    a. Provide the software packages listed below on the server. Packages shall be licensed and fully functional. CONTRACTOR shall coordinate version with OWNER to ensure versions are compatible with OWNER software.

        1) Microsoft Word

        2) Microsoft Excel

        3) Adobe Acrobat Pro (Adobe Acrobat Reader shall not be acceptable)

7. HISTORIAN

    a. Machine Type: Rack-mount multi-processor, RAID 1 multi-drive, server grade computer. Specific application should be stored on the RAID 1 drives with the OS.

    b. Operating System: MS Server Platform

    c. Specifications and Features: As recommended by the HMI application vendor to support the required control screens and I/O density.

    d. Special Instructions: Collected data shall be routed to the scalable NAS RAID 6 storage device.

C. Uninterruptable Power Supplies (UPS)

1. Provide and install online UPSs where indicated.

2. Each UPS shall maintain power to all its loads for a minimum of thirty (30) minutes. The equipment submittal shall include sizing calculations which support the unit selected.

3. Switching or line-interactive type UPS are not allowed.

4. The UPS manufacturer shall be N1C. Model No. N1CL3000 in server cabinet.

2.5 LOCAL AREA NETWORK HARDWARE

A. Manufacturers:

1. The Ethernet managed switches shall be **by Rockwell Automation, Stratix 5200, or equal.**

2. Network router shall be by Cisco, or equal.

B. Description:

1. Network devices shall be furnished and installed by the Contractor as detailed in this section and as shown and/or specified on the Architecture or Network Block Diagrams. Firmware modules, where applicable, shall be installed. The network devices shall be of the latest revision. If the specified model has been or is currently scheduled to be discontinued by the manufacturer, the Contractor shall furnish (with the approval of the Engineer) the manufacturer recommended replacement model of equal or better functionality, performance, and reliability.

2. The Contractor shall also be responsible for configuring new and if applicable, the existing network hardware, verifying the firmware, adding communication modules (and other network hardware components as specified) and configuring the network modules to ensure successful working integration with the control system communication network per the contract requirements.

C. Performance / Design Criteria:

1. The new LAN hardware shall comply with the IEEE 802.3 standards for Ethernet and operate at a minimum bandwidth of 100Mbps.

2. The network topology shall permit either switched 100BASE-TXor 1000BASE-TX connections through an auto-negotiating switched hub.

D. Materials / Components:

1. Network Switch

   a. The Contractor shall provide an industrial type 24-port redundant Managed Ethernet Switch at each of the locations identified on the drawings. Each port shall provide a dedicated 100Mbps (200 Mbps in full duplex) connection between the switch and a node. Each port shall be auto-negotiating (speed and duplex mode) to allow for the fastest possible connection.

   b. The switch shall be configured per IEEE 802.1d Rapid Spanning Tree Protocol (RSTP) supporting Ethernet TCP/IP communication. The Managed Ethernet Switch shall be able to connect to industry standard fast Ethernet 100BASE-T or 100BASE-TX media type. There shall be a software protocol layer that uses TCP/IP as the transport mechanism to deliver packets of data to other equipment that use the same protocol.

   c. The switch shall have at least one medium dependent interface/medium dependent interface crossover (MDI/MDIX) configurable port and shall have memory dedicated for media access control (MAC) address storage.

   d. It shall be supplied with all necessary power supplies, connecting cables, and software as necessary to obtain the specified functionality.

   e. The switch shall be installed in a location where no cable runs to the server, workstations, printer, server, or fiber router exceeds 200 feet.

   f. Additionally, the switch shall meet the following requirements

      1) Power Input- 24 VDC

      2) UL listed

      3) Din rail mount

      4) 30-percent of the ports shall be kept unused (spare)

2.6

2.7 PERIPHERAL DEVICES

A. **General:** Peripheral devices shall be furnished, installed, and configured by the SYSTEM INTEGRATOR (and the SELLER of each package system) as detailed in this section and as shown and/or specified on the Control Network Diagrams. Firmware modules, where applicable, shall be of the latest revision. If the specified model has been, or is currently, scheduled to be discontinued by the manufacturer, the SYSTEM INTEGRATOR (or package system SELLER as applicable) shall furnish (with the approval of the ENGINEER) the manufacturer recommended replacement model of equal or better functionality, performance, and reliability. The CONTRACTOR shall be required to furnish, install, terminate, and test communication interface cabling and fiber optic cabling (all as specified herein) to support interconnectivity of the control cabinets, communication/server cabinets, field equipment, etc. all as shown on the Control Network Diagrams. The SELLER shall be required to furnish panel mounted peripheral control and networking devices as shown on the Control Network Diagrams and

specified herein. The supplier (i.e., SYSTEM INTEGRATOR or SELLER) of a given cabinet, panel, control station, or console shall be responsible for supply and installation of all internal conductors, cables, UTP jumpers, fiber duplex jumpers and supporting patch panels.

B. The SYSTEM INTEGRATOR shall be responsible for configuring the network hardware, verifying the firmware, adding communication modules (and other network hardware components as specified), and configuring the network access control appliances. The SYSTEM INTEGRATOR shall be responsible for coordinating network hardware configuration, addressing, and firmware usage with the packages system SELLERs to ensure equipment compatibility, reliable communications, and consistent security policy implementation across the network (inclusive of all SPLCS package systems).

C. Firewall Appliance: Edge protection Firewall shall be manufactured by **Fortinet, FortiGate 401F Model**. The installation shall employ a zero-trust policy where inter-network communications are concerned with only machine-level data push-to or pull-from the CS-LAN DMZ-2 VM servers permitted. The firewalls shall be configured to enforce this policy, directing all unvetted remote users to CS-LAN DMZ-1 for RADIUS authentication and authorization before allowing login access to CS-LAN DMZ-2 VM Host Jump Services Server. Credentialed users accessing the CS-LAN DMZ via the business network shall be permitted to login to the CS-LAN DMZ-2 VM Host Services Server. As shown on the Control Network Drawings, the DMZ-1 firewall will be required to directly interface with the CONTRACTOR furnished ISP router VPN service and will need to be established as a secured public-facing VPN gateway with settings coordinated with the ISP router settings. The firewalls shall also be configured to only permit routing of white-listed protocols and data types and shall actively scan for and restrict passage of electronic viruses. The furnished firewall appliance shall support stateful packet inspection, network segmentation, creation, monitoring, and secure traffic management of multiple DMZs. Furnished firewall appliance shall include 16 gigabit RJ45 ports, 8 gigabit SFP slots (populated as shown on the control network diagrams) and hot-swappable redundant power supplies. The SYSTEM INTEGRATOR shall be required to configure the firewall in accordance with the directives issued by the OWNER and the ENGINEER following the Network Coordination Meeting (agenda outlined below).

D. The CONTRACTOR shall schedule two 4-hour Network Coordination Meetings with the SYSTEM INTEGRATOR, the ENGINEER, and the OWNER to finalize detailed configuration requirements of the items listed below. Within 5 working days of the meeting conclusion, the ENGINEER will distribute meeting minutes which shall serve as direction for the CONTRACTOR on the specifics of the individual installation requirements. The CONTRACTOR shall consider this direction as part of the contract defined work.

1. Network node IP addressing and node naming conventions (including field network nodes)
2. Ethernet switch configuration including:
    a. VLAN usage
        1) IO Maintenance Switch
        2) SCADA Core Switch Stack / PCN Core Switch Stack
    b. Arrangement of stacked switches
    c. Teamed-port arrangements
    d. Establishment of default policies
3. Domain and domain server (primary and backup) configuration.
4. VM host OS configuration considerations, VM instance resource allocations, and Dell Open Manage Software configuration specifics
5. Time server configuration and server clock synchronization
6. LAN traffic management
7. Configuration of the Dragos Network Monitoring Software including:
    a. Identification of key traffic and protocol monitoring
    b. Interface with the various network layers
    c. Creation of default status screens
    d. Alarm definition, management, and distribution
8. Firewall Appliance configuration, DMZ creation, and policy definition
9. RADIUS software configuration, dual-authentication setup, and access list definition
10. Backup server configuration and targeting.
11. Antivirus / Malware server configuration and update distribution
12. Review strategy for propagation of network configuration details to package system SELLERs and subsequent implementation verification

E. Rack-mounted KVM Switch shall be capable of supporting up to (8) workstations or servers and shall be furnished with (1) USB keyboard, (1) USB optical 3-button mouse and an embedded extender transmitter for remote access to the indicated rack-mounted servers. A KVM extender receiver unit shall also be furnished and connected using UTP category 5E cabling. KVM switch and extender receiver shall be manufactured by **Blackbox or Avocent** complete with all necessary cabling (6-ft length) to support a fully populated installation. SYSTEM INTEGRATOR will be required to configure the software and label all server connections.

F. Furnished 19-inch rack-mounted RJ-45 CAT6 patch panels, as identified on the Control Network Diagrams, shall be as manufactured by **Leviton (QuickPort patch panel Model 69270-U24 with Extreme CAT6 connectors** and integral cable management bar**)**, sized to accommodate a 20 percent growth in port usage over that identified on the Control Network drawings. Compact, din-rail mounted RJ-45 modular patch panels (CAT6) shall be manufactured by **Belden, MIPP Model**.

G. SYSTEM INTEGRATOR supplied CAT6 UTP Ethernet plenum cables and patch-cords shall be manufactured by **Belden 7931A CAT6 Data Tuff** with installation and performance adhering to the requirements of ANSI/TIA/EIA-568-C.2. Network faceplates shall be furnished, as detailed in the Control Network Diagrams, all as manufactured by **Leviton, single-gang QuickPort with designation windows**. Unless indicated otherwise, enclosed **Panduit solid wall Panduit wire management systems** shall be used to route exposed network cabling (as applicable).

H. Fiber Equipment/Module

1. Provide Rack Form-factor Pluggable (SFP) modules for the SFP ports on the Network Switch. SFP modules shall be provided for 1000 Base-LX/LH single mode fiber (nominal wavelength 1310 nm).

2. The SFP module in the SFP port has duplex LC type connectors with PC type polish. The contract drawings require a fiber patch panel that has LC type connectors. The fiber patch cable shall be compatible with the above specified equipment; these shall be Belkin F2F802LL-02M or approved equal.

3. Belkin F2F802L7-02M fiber optic-LC/SC Duplex Patch Cable (8.3/125 mm single mode) with PC type polish, or approved equal, shall be provided for connection to an SC type connector patch panel.

2.8 SCADA Server Enclosures

A. Server Racks

1. SCADA Network Sections shall be equipped with an integral 19” rack to accept standard 19” rack mountable equipment.

2. Each Panel Section that includes rack mounted equipment shall be equipped with exhaust fans (minimum two per section) and vertical cable management ducts.

3. SCADA Control Panels that contain SCADA nodes shall be equipped with retractable keyboard drawer, mouse, shelf, have clear panel doors.

4. Manufacturer:

a. Enclosures shall be manufactured by Hoffman Proline.

b. OR approved equal.

B. Server Rack Power Distribution Unit

1. Each Panel Section that includes rack mounted equipment shall be equipped with a managed Power Distribution Unit (PDU).

2. PDU shall have a minimum of 16 power outlets.

3. PDU shall support outlet switching and metering.

4. PDU shall support 120 VAC, 30 Amp service.

5. Manufacturer:

    a. PDU shall be manufactured by Eaton Model EMAU05-10.

    b. Or Approved Equal.

PART 3 -- EXECUTION

3.1 FIELD QUALITY CONTROL

A. The Contractor shall provide the Owner with training on the subjects of use, maintenance, operation, troubleshooting, and repair of all the components of the PLCs and the rest of the PBCS hardware. The training shall be specifically tailored to this project and reflect the hardware and the installation. All training shall be conducted on site unless another location is approved by the Engineer and Owner. Hardware training subjects and the allocated hours for each class shall be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

END OF SECTION

SECTION 40 95 20 - PLC-BASED CONTROL SYSTEM SOFTWARE

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor, through the use of the System Supplier shall furnish, install, assemble, configure, program, and place into service all PCIS and PLC hardware and software as a complete, integrated, and functional PLC based SCADA and communication system to perform the functions specified in the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Section 40 91 00 – Process Control and Instrumentation Systems

C. Section 40 95 10 – PLC-Based Control System Hardware

D. Section 26 05 15 – Industrial Control Panels

E. Applicable Sections in Division 40 – Instrumentation and Control for Process Systems

F. Division 26 – Electrical

G. Division 27 - Communication

H. The PLC based control systems hardware, programming software, software installation and programming, and other work related to the PLC based control systems shall conform to the specifications; codes and standards requirements specified Section 40 91 00 - Process Control and Instrumentation Systems.

1.3 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Software Submittals: PLC Based Control Systems Software submittals and Operation and Maintenance Manual(s) shall be in accordance with the requirements specified in Section 40 91 00 - Process Control and Instrumentation Systems.

1.4 QUALITY ASSURANCE

A. PLC-based control systems software manufacturer's representative services shall be provided in accordance with Section 40 95 10 – PLC-Based Control System Hardware.

1.5 WARRANTY

A. Guarantee and Special corrections of defects and software upgrade requirements and warrantee shall be in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

PART 2 -- PRODUCTS

2.1 GENERAL

A. The application software shall be the latest versions of **FactoryTalk SE or equal,** running on the latest updated version of Microsoft Windows operating system.

B. The Contractor shall provide standard software fully installed for the process control and instrumentation system (PCIS). The software the Contractor provides shall be the latest generation, field proven, fully debugged, and supported software package for this application...

C. Software is described in broad, functional categories. The System Supplier shall furnish a complete software package including the functional requirements along with whatever additional software is required for proper and efficient operation. Customized or specially written software that is commercially available shall be furnished if required to meet all of the functional requirements indicated. Any custom applications of software required shall be fully integrated into the basic software and shall not require unique command structures.

D. The software package shall provide a system capable of controlling system level functions, and a higher-level process control language allowing the operator to monitor and control the process through an interactive HMI. The software environment shall support a multiprogramming atmosphere allowing concurrent execution of more than one program in a background/foreground mode or multitasking mode.

E. Throughout the execution of all software modules, the operator shall be presented with all of the command or operation choices available at that point in the program using sufficient verbiage or symbols to make the choices self-explanatory and unambiguous. Question and answer or fill in the blank requests shall only be permitted where tag names, or other unique text or numerical information is required.

F. Workstations and nodes accessing the central computer system shall be supported by the same software at the central computer.

2.2 PLC PROGRAMMING SOFTWARE

A. The PLC programming software is specified in Section 40 95 10 - PLC Based Control System Hardware and shall be provided under that section. However, the integration of the PLC software into the PLC Based Control System Software shall be part of and in accordance of this section.

2.3 HUMAN MACHINE INTERFACE (HMI) - STANDARD APPLICATION SOFTWARE PACKAGE

A. General:

1. The standard application HMI software package shall be a standard fully developed, field tested/proven, and commercially available product. It shall be a real-time multi-tasking process monitoring and control software application. The software modules, as described below, shall be able to provide for the collection, manipulation, and storage of real-time data necessary for:

a. Display, reporting data and events, and historical record keeping functions and, in a format, appropriate for its use and function.

b. Communication to remote PLCs for the collection of data and transmitting control commands.

c. Issuing automatic and operator-initiated control commands; manual manipulation of the database; and the retrieval and use of historical data.

2. The HMI software package shall be capable of and support:

a. Control interface redundancy to ensure high availability of operations and maintenance of process/process equipment monitoring and control tools at all operation levels.

b. Full-redundant hot-standby configuration between the I/O servers.

c. High resiliency and calibrated availability of management suited business and regulatory analysis tools.

d. Package systems' dedicated operator interface (operating independent of and in parallel with the plant control system HMI) ensures availability of at least one interface.

e. Management level remote desktop client workstation allowing management level operators to assume full control of any facility for scheduled periods or on a permanent basis.

f. Remote access to web-based clients.

g. Maintenance of web-based clients allowing maintenance level staff to actively monitor any site and work in parallel with management or facility staff to troubleshoot process control issues and evaluate response to critical alarm conditions.

3. On-Line Configuration: The software shall be capable of performing on-line system configuration while the system is operating. Modifications shall include adding, deleting, and/or modifying database definitions, operator displays, PLC configuration, control strategies, and reports without having to interrupt the data acquisition.

4. Source code modifications, re-assembly, or recompilation are not acceptable.

5. System Size: The system software shall be provided in different sizes to meet various application needs. Ideally, the sizes would be for tag counts of 5,000, 10,000, and 30,000, and no limit for systems with I/O attached. As a minimum, the number of tags shall be the same number of total PLC I/O count, including spares.

6. The system shall provide complete user documentation, including examples of how to operate the various modules within the system. An on-line "help" facility, based upon Windows standard. Help menus, tutorials, and error codes and/or messages shall be provided.

7. Software Distribution: The software function specified may be performed by the PLCs, the central computer, or an off-line computer depending on the specific function. Certain portions of each software module may be specified to be performed by a specific machine or inherently required to meet the functional aspects of the specified performance. Functions not specified as to location of performance may be performed at the location normally utilized by the software manufacturer's standard software design. In any case, the distributed software shall function as one integrated package to meet the overall requirements of the system. By virtue of the software distribution, the software shall also support a distributed type control system.

8. Multiuser Operation: The HMI shall support a multi-user operating system without any modification to the operating system(s) native code, while creating a true client/server environment that embodies the following attributes:

    a. All features and graphics on server application can be made available to remote client. Client nodes, under authorization from the server node, have the ability to control as well as view the real-time data originating from the server node. All access rights and privileges shall be administered from the server only.

    b. The HMI software shall support Thin Client architecture, whereby a client machine will be able to access the application software graphic displays for monitoring and control without requiring additional full application software to reside at the client machine.

    c. Any changes to the application can be administrated solely from the server node and do not require corresponding changes at the client node(s). For example, additions and/or modifications to graphic displays at the server shall be automatically propagated to the client nodes. No separate graphics configuration tools shall be required for the client nodes to access server data.

9. Software Updates: All software shall be updated with the latest service packs and/or patches unless the update is not compatible with or is not supported by other integrated software in the system. The update, if available from the software manufacturer, shall take place as necessary during the project construction period: at least during initial system configuration, prior to the factory acceptance test and during system packages and start-up prior to the 30-day final acceptance test.

B. Primary and Secondary SCADA I/O Servers

1. Required Operating System for the server(s): MS Windows Server platform (recommended) or Pro platform.

2. HMI software shall run on Windows 10 operating system.

3. The basic function of the primary I/O server is to function as an HMI communication interface to PLC units. The server shall poll the I/O addresses of each PLC while servicing user request interrupts. The server shall also support data transfer to the various client workstations.

4. The secondary I/O server shall be identical to the primary server and shall backup the HMI communication interface to PLC units. In the event of a failover, the backup server shall be capable to poll the I/O address listing of each PLC while monitoring

the status of the primary server. In the event of a primary server fault or primary server application fault, the secondary server will be immediately elevated to primary server status.

5. The HMI application software should be stored on Drive 0 with the Operating System (OS). Application data shall be stored on Drive 1.

6. The I/O server and the software shall perform the following functions:

    a. HMI to PLC communication

    b. HMI to Historian communication

    c. Configured for hot-standby failover

    d. Detect the following faults to auto initiate failover:

        1) Gateway/driver/communication module failure (e.g., OPC Server watchdog timer active/inactive).

        2) Application failure

        3) Loss of server or server communication link

C. Redundancy and Failover: The two I/O servers shall be configured in a full-redundant hot-standby configuration connected and configured via local area network. The servers shall be identical in hardware and software to provide one server as the backup to the other. Server may be optionally configured as default primary OR established as the primary server until fault or manually forced to secondary status. In either case, the server should be configured to continuously collect data in parallel with the secondary server.

1. Under normal conditions, the on-line (primary) server shall perform data collection, and all normal monitoring, control, alarming, archiving, and reporting functions. The configuration shall keep the offline (secondary/backup) server updated in the event of failure of the primary computer and so that the Owner will be able to access the offline server for all operational functions. The system shall keep track of which server is the primary and which is the secondary server.

2. In the event of the primary server failure, the configuration shall provide an automatic bumpless switchover to the secondary server. There shall be no data loss due to the immediate transfer from the primary on-line operating server to the secondary server upon, and the collection of data shall proceed uninterrupted.

3. Network laptops shall be able to connect to either of the two servers, and shall be capable of adjusting set points, acknowledge alarms (alarms shall be acknowledged once at either machine), etc. through that computer. If the primary computer fails, the user on the network computer shall be notified to reconnect/re-log to the other computer. This reconnection shall be manual.

D. Stand Alone Configuration

1. Without Networking: In non-networked applications, the software shall be capable of performing all desired functions (data acquisition, graphics, trending, reporting, etc.) within a single computer.

2. Adding a Network: Should the Owner elect to network the computers at a later time, all that shall be required is to connect each computer to the local area network and enable the networking functions within the software. Neither reconfiguration nor duplication of database tags shall be required to make data available to other nodes that require access to it.

E. Data Management

1. General

   a. The server software shall provide an application independent data storage and analysis tool capable of receiving, selectively storing, analyzing, repurposing and then selectively forwarding re-formatted data to any (and multiple) database driven application. Application should include high density data support (scalable for the life of the facility), integral reporting functions, graphic webpage generation, reduced-packet data transport, multi-protocol support, and redundant server resolution support.

   b. No programming, compiling, or linking shall be required to configure the system. The database tags must be configurable on-line. The new function and database tag assignments shall be added while the system is performing data acquisition and control operations.

   c. The process database containing the current value of the data, or tag list, shall be memory-resident and of a design that is appropriate for real-time monitoring and control functions. Its design shall be optimized for speed, memory usage, data integrity, and system security. Floating-point arithmetic shall be used in all calculations.

2. Data Integrity: The software shall provide pre-emptive multitasking to ensure that common Windows actions do not interfere with I/O communications, processing of data, alarming, and the integrity of the real-time and historical data.

3. Database Tag Configuration

   a. Various input/output hardware assignments, as well as processing functions, shall be assigned to named tags or “function blocks". Multiple tags may be tied together to perform more complex functions. During the configuration process, the program shall be capable of checking the tag structures for correct linkages, appropriate names, and so on. The scan processing program shall also be capable of detecting and handling configuration errors at runtime. Any errors encountered shall generate messages to the user.

   b. Configurations that are not attached to I/O and do not contain tags shall also be available. These systems shall be available with 2 types of rights to a tag: with rights to read and write to tags in other nodes, and with rights to only read tags from other nodes. These rights can be controlled by the developer using security.

c. The user shall be able to perform tag configuration such as adding, modifying, deleting, and viewing.

4. Database Tag Types

a. Analog Data Base: A comprehensive data base shall be furnished for the analog inputs, calculated values, control modules, and outputs. In addition, spare data base points shall be provided for future expansion. All portions of the database shall be available for use by the display, report, and other specified software modules. In addition, spare data base points shall be provided for future expansion to match the PLC spare I/Os and as specified.

1) Blocking: It shall be possible to inhibit or block the scanning and/or processing of any analog input through the central computer. For any input blocked, it shall be possible for the operator to manually enter a value to be used as the input value. The blocked value shall be maintained at the PLC.

2) Linearizing: Where analog inputs require square root extraction or other linearization, means shall be provided at the PLC to condition the filtered data before the process of scaling and zero suppression takes place.

3) Scaling and Zero Suppression: A conversion program shall be provided to convert input values into engineering units in a floating-point format. This function shall be performed at the PLC.

4) Alarms: An alarm program shall be provided to check all analog variables against high-high, high, low, and low-low alarm limits. When an analog value exceeds a set limit, it shall be reported as provided under “Alarm and Status Reporting” based on individually set priority level for each alarm point. There shall be an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit. Return to normal shall also be reported. This function shall be performed at the PLC, including alarm and acknowledge status.

5) Averages: Averages shall be continuously computed, and have a selectable time period and shall be performed at the PLC.

6) Totals: The PLC shall calculate totalization of analog variables. There shall be a scaling factor assignable to each variable to convert to the appropriate units based on a selectable interval.

7) Control Modules: For each control function configured whether processed at the PLC, there shall be maintained a file of necessary data including input values, set points, constants, output value, and limit clamps, etc. Input and output assignments, set points, and constants shall be adjustable by the operator through the central computer. Control algorithms shall provide for manual control, and output values shall be adjustable by the operator as described under “Control Functions” below.

8) Calculated Values Means shall be provided to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated value, constants, etc. These values shall be handled the

same as real inputs in terms of record keeping, alarming, etc. The calculated values shall be performed at the PLC.

9) Real-time Trend: This tag shall take as its input an analog or calculated value. Averaging of accumulated input values will be provided to extend the amount of time represented by the trend block. The data within the tag can be graphically depicted on operator displays.

b. Digital Data Base: A comprehensive data base shall be furnished for the digital inputs, calculated points, control logic, and outputs. In addition, spare data base points shall be provided for future expansion to match the PLC spare I/Os and as specified. All portions of the database shall be available for use by the display, report, and other specified software modules. The digital data base software shall support the following functions and attributes:

1) Blocking: It shall be possible to inhibit or block the scanning and/or processing of any digital input through the central computer. For any input so blocked, it shall be possible for the operator to set the state of the input. The set value and its block value shall reside at the PLC.

2) Status and Alarm: Each digital point shall be assigned a priority level for change of state reporting as provided under “Alarm and Status Reporting” below. It shall be possible to set different priority levels for change of state in one direction as opposed to the reverse direction. The alarm and acknowledged status shall be maintained at the PLC.

3) Totals: The PLC shall calculate and store run time and number of start totals of digital inputs. At the end of each totalizing period, the totalized values for the period shall be sotred for historical records and the totalization register shall be reset to zero. There shall also be provided a non-resetting (lifetime) run time and number of start totalizer functions.

4) Digital Outputs: Digital outputs shall be maintained as part of the data base. Software shall be provided to allow for single (two state) and dual (three state) output types. Output change of state shall be reported as described for inputs above. It shall be possible for outputs to be set manually by the operator through the central computer or automatically through control logic and sequences.

5. Tag Attributes:

a. Each tag shall have an instrumentation tag name of up to 30 characters. The name shall be alphanumeric. All other application programs shall use this tag name as their sole reference to the data element assigned.

b. Scan rates shall be able to be set independently for each appropriate tag. Longer scan rates of up to once per 24 hours shall also be supported.

c. Alternatively, the user may elect to have tags processed on an exception basis. This choice shall be allowed on a tag-by-tag basis.

d. Also, any input tag may be configured as a “one-shot.” This will cause it to fetch the value from the I/O device just one time when the system is started, or the tag is brought on scan.

e. Each tag associated with a hardware address or capable of causing an alarm condition shall have a means of displaying a descriptive message on the alarm printer. The descriptor shall be at least 40 characters in length.

f. For tags assigned to actual hardware points, they shall also contain fields for:

1) Hardware device name

2) Hardware address

3) Hardware specific parameters

4) Signal conditioning requirements

6. Database Packages:

a. SQL (Structured Query Language) Package. This package shall consist of 2 database tag-types, the SQL Data and the SQL Trigger. It shall utilize Microsoft’s Open Database Connectivity (ODBC) for connection to the external ODBC-compliant database.

b. The SQL package shall support ANSI SQL commands to facilitate database reporting requirements. These commands shall be generated by the system without requiring the user to explicitly know or write SQL code. Provisions shall exist for users to modify existing SQL queries to satisfy additional reporting needs. It shall be possible to generate a set of standard reports from the collected and logged data, for use as a minimum, to summarize logged data for data analysis. It shall also be possible to print and/or store in the computer any reports generated.

c. Control package: This package shall include standard functions such as PID, Lead/Lag, Ratio/Bias, ramp, on/of, signal selector, high/low, etc.

7. Database Logging: Database: logging shall be supported for defined system points for configured system events. Database logging shall support relational database connectivity for commercially available databases such as Oracle, and ODBC compliant systems. The architecture shall execute SQL commands for the pertinent read/write operation. The system shall implement the database-logging scheme to permit configuration without users being required to write SQL type commands. In addition, the system shall support database logging to the extent that table, row, column, index, and stored data are user definable in accordance with the following and permit setup without written SQL commands:

a. Table definition: The system shall support a table or schema definition of the selected relational database management system (RDBMS). This table definition or template shall be reusable for other table structures. Data types supported for column definition shall include small integer, integer, float, character, and date formats. Data formats may vary depending upon selected RDBMS.

b. Data Ordering: The system shall support data ordering via sequence number or equivalent for logged data. Data ordering sequence shall be definable in the schema definition for the data table.

c. Data Indexing: The system shall allow indexing for stored data in any data table. Multiple indexing shall also be supported.

d. Database connections: The system shall support multiple database connections for read/write operations. As a minimum, 10 database connections shall be supported. Database connectivity through the above relational databases shall support a local or remote database connection as supported by the system to support enterprise connectivity.

F. Communication

1. General: Server software shall be capable of providing efficient and secure data transfer between the servers and peripherals, and other terminals. The system shall support communication with a variety of external input/output (I/O) devices. The devices that can be interfaced to the system shall include:

a. PLCs: interface via network, radio, PLC manufacturer-supplied interface cards.

b. Remote I/O.

c. Intelligent controllers and equipment (e.g., smart starters, etc.).

2. Scanning and Communication Features: Communications software shall include the following features and capabilities:

a. Display-only Communications: To facilitate more efficient communications with PLCs, the system shall be able to provide display-only communications. Communications to read or write tags (Analog Registers and Digital Registers) will only be established when a graphics display containing these tags is open. When the display is closed, communication will cease.

b. Communication Ports and Drivers: The system shall be capable of simultaneously supporting different types of communications drivers and network ports. The communication drivers shall be configurable on-line.

c. Interrupts: All communication ports employ interrupt techniques to reduce polling overhead.

d. Buffering: All communication ports shall be fully buffered.

3. Communication and Data Error Detection and Recovery:

a. Communications between the servers and the PLCs shall include error checking codes and schemes to ensure a probability of erroneous message acceptance. These error checks shall include lost response (time-out) and data error.

b. All messages shall be acknowledged to indicate that they have been properly received. Failure to receive a message of acknowledgement shall cause the

message to be retransmitted. The number of retries shall be user definable. If a proper reply is not received within the set number of tries, a communications failure alarm shall be generated.

c. Should communication errors be detected, the software shall automatically indicate that the data is no longer valid and shall replace the invalid data with other characters. The system shall automatically attempt to re-establish communications, and, if successful, shall then replace the characters with valid data. These capabilities shall be built-in to the software and shall not require any user programming or other actions to implement.

d. Failover to a user-configurable back-up port shall be provided as a standard function of the driver. This capability shall cause the software to automatically attempt to establish communications between the computer and the I/O device via the second communication port when it has been determined that the connection via primary communication has failed.

e. Diagnostics: The system shall provide a diagnostic program capable of running on-line or off-line that can monitor message rates from the communication program. The diagnostic will display the number of new messages, retries, time-outs, and any occurrences of error. For serial drivers, a built-in data scope shall be provided. This data scope function shall allow the user to observe the messages being sent between the computer and the I/O device.

4. Communication Protocol and Scanning of Remote Sites

a. The server shall scan the PLCs on a sequential polling basis using the performance criteria stipulated in Part 3 - “Execution” of this Section. The Contractor shall provide the means to set up a poling priority scheme where various sites can be poled at a different frequency. The poling scheme shall be programmable and coordinated with the Owner during construction.

b. I/O Driver Toolkit: A toolkit must be available which will allow the creation of I/O drivers by end users, system integrators, and others.

G. Graphic Displays

1. The graphics package shall provide a means of creating and displaying color graphic displays of data, control and monitoring tools, and reports that will be used by the operator to monitor and control the process. Real-time values being read from the field devices shall be capable of being displayed in a variety of user-configurable formats. There shall be no limit (other than physical memory storage size) to the number of displays that can be developed and accessed online.

2. The development and runtime graphics packages must both be multi-document architecture applications with the capability to each support up to 10 open displays simultaneously.

3. The displays specified in the EXECUTION portion of this specification section shall be configured by the System Supplier and delivered with the system in complete operational form. Additional displays shall be configured on-line during the acceptance test period.

4. The graphic display program shall provide the general attributes and display types listed below.

    a. The system shall provide an interactive object-oriented editor that allows creation of graphic displays.

    b. A facility shall be provided that quickly toggles between the graphic building and graphic runtime modes to speed display animation verification during the development process.

    c. The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system shall not be required to make changes.

    d. Color Support: The graphics package shall provide support for an unlimited choice of colors with 256 colors supported at any one time. The user shall have the ability to create, save, and restore custom color palettes.

    e. Graphic Toolbox: The system shall have a configurable graphic toolbox that the graphics developer can customize as to what tools it contains and change their position in the toolbox. Once configured, the state of the toolbox shall be automatically saved when the drawing session is completed. It shall be returned to that same condition when the next drawing session is started.

    f. Graphic Animation: Each display must have the ability to dynamically update elements in the picture. Defining the method for dynamic update shall be determined by a point and click operation.

    g. Paging: It shall be possible to page from one page to another related page using a vector "poke point". Alternatively, a display menu paging system may be employed.

    h. Point Displays: For each analog and digital input, calculated/control point, and outpoint there shall be provided a point display. These displays shall have a standard format for each point type and shall show all data pertinent to each point (point number, name, I/O address, filter and scaling factors, calculation, alarm limits and priority, set points and tuning constants, scan status, operational status, etc.). An operator shall be able to modify a configured point online through the point display.

    i. Alarm Summary Display: Provisions shall be made for an alarm summary display as described under "status and alarm reporting" herein.

    j. Graphic (Free Form) Displays: The graphic or free form displays shall allow for any combination of text, data (real-time updated), symbols, geometric shapes (lines, arcs, rectangles, eclipses), bar graphs, and vector "poke points" to be displayed on the screen. It shall be possible to tie any of these items to a point in the database to allow them to change color, size, value, etc. in response to changes in the database. Additional details relative to symbols, use of color, data base interface, etc. are presented herein under "Display Editor".

    k. Trend Displays: Trend displays shall be provided to allow data to be presented in a trend or strip-chart like format. It shall be possible to trend both live and

historical data as defined below. Each defined trend shall be capable of displaying at least four variables. Each trend variable shall be displayed in its own unique color, including its engineering range/scale and timeline values. It shall be possible to define an engineering range/scale for a trend that is different than that of the point's defined range/scale.

1) Live (Real Time) Data Trend: It shall be possible to select any and all points in the data base for trending. A separate trend file shall be maintained for all points so selected. The trend time interval shall be individually selectable by the operator.

2) Trending shall be able to display data from a combination of databases. A single chart shall be able to display pens from multiple databases simultaneously.

3) Historical Trend: The Historical Display package shall have a multi-document architecture. It shall be possible to define a trend display from the historical data base and display it in a graphic format. The display of archived data shall be user configurable.

4) Historical trend windows must be able to update with newly collected data at time intervals, as selected by the user.

5) For these trends, it shall be possible to define the end point for each trend program as the present point in time or any other time, and/or date and period. It shall be possible to retrieve the live data trend file for analysis (see live data trends above).

6) The historical trend display shall be made up of a pen group, time group, and legend group. The display shall support up to 8 variables to be displayed simultaneously. For each entry, the operator will be able to assign a given tag name and marker to a particular line color selected from a palette of 256 colors.

l. Operator Interface: Software shall be provided to allow the operator to perform control selection, manual control, and acknowledgement function interactively through the screen displays. It shall be possible to perform these functions through an interactive window. It shall be possible to call the window by positioning the cursor, mouse pointer on a symbol or data field that is tied to a data base point and pressing a single key or clicking. The type of equipment, item or data point called will determine the exact operation that can be performed but, in general, provisions shall be made to allow for control mode selection (manual, local auto, central auto), manual mode commands (start, stop, etc.) alarm acknowledgements, set point adjustments, interlock resets, and totalizer resets.

5. Display Editor: The display editor shall allow for the creation of new displays and the editing of existing displays. The editor shall also provide for saving these screens to the system screen data base as new or replacement screens in a manner that allows them to be called by the operator utilizing the methods specified under "displays" above. The editor program shall operate on-line with the monitoring and control program, and in the background. The program man/machine interface shall be interactive in nature and shall provide prompting through menus (or similar

device) from which appropriate selections can be made. As a minimum, the editor program shall provide for the following functions and features:

a. Select Edit Mode: When the editor is first started (and at other appropriate times as required) the program shall allow for selecting the editor mode. The available selections shall include (as a minimum) NEW, LOAD, EDIT, SAVE, and QUIT.

b. Select Edit Function: When the edit mode is first selected (and at other appropriate times as required), the program shall allow for selecting the edit function. Available selections shall include (as a minimum) ADD, DELETE, COPY, RESIZE, and MOVE.

c. Select Symbol: After an edit function has been selected (and at other appropriate times as required), the program shall allow for a specific symbol to be added. Available symbol groups shall include (as a minimum) GEOMETRIC SHAPES, EQUIPMENT SYMBOLS, ALARM SYMBOLS, TEXT, DATA, BAR GRAPH, TREND GRAPH, and VECTORS. A library of objects shall be included with the standard product.

d. Assign Symbol and Object: It shall be possible to assign any symbol that has been selected to any attribute of any point contained in the configured data base. Status and alarm data points and attributes shall allow for color changes and alternative message displays. Analog data points and attributes shall allow for (one) dimensional change and actual numerical value display. Assignments shall be through menu selection. It shall also be possible to tag equipment “out-of-service” and display it on the screen. Objects may be assigned to more than one dynamic property. In addition, objects within groups may have individual dynamic properties in addition to those dynamic properties assigned to the overall group.

e. Select Color: It shall be possible to set the color of a symbol for each possible state of the data base point that the symbol is assigned to, or to a fixed color if the symbol is not assigned to a data base point. It shall also be possible to set the background color and intensity. The normal color uses shall be standard application software colors already used. Colors for the operational and status of functions and other symbols will be determined by the Owner.

f. Graphic Refresh Rate: The refresh rate shall be user definable.

g. Sources of Data for Object Animation: The animation of the graphics and objects with dynamic properties shall be able to be linked to any type of data.

h. Reusing Graphic Objects and Displays: A method shall be provided for allowing graphics of objects or groups of objects to be reused easily. In cases where the system has multiple similar displays, the displays shall be able to be used as a template and later customized for reuse purpose.

i. Tag Groups: The system shall provide a method of grouping tag names in a file such that specific tag names are provided to a generalized display.

j. Automated Picture Generation: Displays shall be able to be generated automatically by importing the re-usable graphic objects into pictures.

k. Multimedia Capability: Support for standard Windows multimedia capabilities, including audio and video, shall be provided.

l. Documenting Graphic Displays: Printing of graphic displays in color and black and white shall be supported via the standard Microsoft Windows Print Manager in both the graphics development and runtime environments.

H. Alarms and Status Reporting

1. General: Software functionality shall be provided for the detection and reporting (alarming) of any change in the state of a digital input or the change of pre-determined value limits of analog variables. Detection and reporting shall also be provided for operator entered commands, deviation from control set points, watchdog timer reset, and modifications to the system operating parameters. The alarm conditions shall be detected even if the variables causing alarms are not currently on the display.

2. Alarm Configuration

a. Alarm messages shall be independently user configurable as to what information is provided and its sequence within the message. The following choices shall be available:

1) Time of the alarm

2) Name of the tag causing the alarm

3) Alarm condition code

4) Engineering units value when the alarm occurred

5) Descriptor text assigned to the tag

6) Engineering units of the tag

b. Alarm limits shall be entered initially by the user at configuration time or from the operator's display during run-time. Changes to alarm limits or conditions shall be able to be entered at any time afterward by the Owner. Alarm limits are expressed in engineering units.

c. Alarm Priorities and Filters

1) Each alarm and status point shall be assigned a priority level to indicate how that point is to be reported. The system shall support at least three (3) alarm priorities for each alarm type as listed below. A filtering mechanism shall be provided so that the operator can adjust the system's alarm priority. Special alarm messages (such as I/O failure) shall be able to be masked

a) Priority 1 - highest level - shall require acknowledgement and cause the audible alarm to sound. Operator entries shall be considered Priority 1.

b) Priority 2 –medium - changes shall require an acknowledgement, but shall not cause the audible alarm to sound.

c) Priority 3 - lowest level - status changes shall not require acknowledgement nor cause the audible alarm to sound.

2) The alarm summary display must provide sorting and filtering capabilities. The user shall be able to filter on node name, alarm area(s), alarm status, and alarm priority. The user must be able to sort on time, tag, alarm area, alarm priority, and alarm status.

d. Alarm Counters: There shall be a built-in method that keeps track of the current number of alarms in various categories: These values shall be available to be used as display information or to create actions, such as setting outputs.

3. Alarm Display, Notification and Acknowledgment

a. An alarm summary display (multiple page as necesssary) shall be provided to allow the operator to view the points presently in alarm and all status messages received. The alarm summary display shall be a pre-defined dynamic link within the graphics package. This alarm summary display must show a list of the new and pending alarms in the system. As new alarms are detected, entries are made to the display list. As the alarm conditions clear, the entries are removed from the list.

b. The display shall provide for at least 100 messages arranged in chronological order with the most recent alarm being at the top of the first page.

c. Each display point shall include data as for the historical record. Through the use of color and blink function, the display shall discriminate for each point based on an alarm or return to normal status, and whether the alarm has been acknowledged.

d. When a new alarm condition is detected, an alarm message shall be generated and shall flash until the alarm is acknowledged. .The operator shall be able to acknowledge each alarm received through the alarm display. Beeping the computer's speaker when an alarm occurs and silencing the sound when acknowledged.

e. An alarm notification shall be accompanied by beeping the computer's speaker. Alarm acknowledgement shall silence the sound.

f. The system must be capable of "freezing" the highest alarm status value on the display until acknowledgment is made. Once acknowledgment is made, the system will display the current alarm status text.

g. The operator shall have the ability to purge the alarm display of data no longer required. A “purge” shall remove from the display all operator commands and inputs, all acknowledged status change messages, and all alarm messages that have been superseded by a later message. It shall be possible to print the alarm display on demand.

h. When an alarm is acknowledged from any node on the network, the acknowledgment shall be made directly at the node from which the alarm was generated, and a message indicating that it has been acknowledged shall then be distributed to all alarm destinations.

i. Messages shall be able to be designated as “events-only.” These will be distributed to alarm destinations but shall not require acknowledgment.

4. The software shall provide built-in capabilities to support the following additional alarm functions:

a. Alarm Color Code: Ability to specify the color codes to indicate the various alarm conditions.

b. Remote notification and acknowledgment

c. Alarm suspension

5. Alarms signals shall be sent via SMS and email to registered users using Win-911 auto dialer software system.

I. Archiving, Retrieval and Reporting

1. The system must provide a facility for automatically collecting, storing in a mass storage server (see HISTORIAN in this section), and recalling data. Recalled data will be made available to a trend display program, a report generation program and to user-written programs

2. Archiving and retrieval shall be performed automatically (periodically), on demand, or in an interactive manner whereby the operator shall be able to select which files or group of files would be copied. All archiving and retrieval functions shall be performed on-line, including reading to or writing from a server.

3. Data File Handling

a. Data will be stored in Windows-compatible files in a compressed format. Compression will be performed through a user-supplied deadband. Entries containing time, name, value, and status will be made in the file whenever the real-time value exceeds the previously stored value by the deadband limit. A deadband value of zero will cause an entry in the file each time the real-time value is examined.

b. Files shall be organized according to time and will contain values for multiple, named variables. The file can be placed on the hard disk or a floppy disk and can be placed on a file server if LAN server software is installed.

c. A mechanism for online maintenance and automatic purging of files must also be provided.

4. Reports:

a. Software shall be provided to allow for the automatic (periodic) or on-demand printout of pertinent real-time and historical data in set report formats. The

reports specified in the EXECUTION portion of this specification section shall be configured by the System Supplier and delivered with the system in complete operational form. Additional reports shall be configured on-line during the acceptance test period using the report editor program.

b. Report Editor: The on-line report editor shall allow for the creation of new reports and the editing of existing reports. The editor shall also provide a method for saving these report formats to the system report format database, including the report print schedule. The editor program shall allow for free form typing of fixed text and data fields to set the format. This shall be followed by a listing that specifies the associated data base point (and attribute) or calculation to be performed for each data field.

5. Spreadsheet and Other Programs: The Owner intends to use the system's historical and maintenance data in a commercially available spreadsheet or other programs. Therefore, the data shall be saved in industry-recorded formats. The data shall also be able to be accessed directly via the open access ODBC software. The Contractor shall provide in the software the means to extract (export) historical data from the historical files in a form which is compatible and transferable to the format used by an industry recognized spreadsheet program or other program (e.g., MS Excel, MS Word). It shall be possible to export logged data in spreadsheet format.

J. Control Functions

1. The computer system shall be capable of performing control and logic functions both at the PLCs and the central computer. Local control, logic, and interlock functions shall be performed at the PLCs, whereas system-wide functions shall normally be performed at the central computer. Specific control functions to be implemented under this contract shall be as specified under the "EXECUTION" portion of this Section and the Drawings. General control capabilities shall be as follows:

a. Control Configuration: Software shall be provided to allow control strategies to be developed, and their operation initiated through the central computer system. Standardized control point displays shall allow for defining the control functions including the function type, input/output addresses, set points and tuning constants, etc. In a similar manner, it shall be possible to link separate control functions together into an integrated control strategy. It shall be possible to download operational/control set points developed in the central computer to a PLC for operational implementation. It shall also be possible to define and implement operational/control set points locally at the PLC and to upload them to the computer for operation record keeping.

b. Operator Control: All programming commands related to changing system configuration or controlling field devices shall be performed only through the PLC system and shall require more than one keystroke to protect against inadvertent operations. The PLC system configuration commands shall require operator confirmation of a requested action before any change is made. This shall apply to changes in the algorithms, control sequences, and similar configuration related actions, as well as file copy and file delete commands. If any sequence requiring operator conformation, the operator shall be able to cancel the operation at any point prior to executing the command.

c. Operator Interface: The operator shall have access to and the ability to alter control parameters such as set points, tuning constants, time delays, etc. as well as the ability to select between local automatic, central, and manual control modes and to perform output manipulations in the manual mode. All such operations shall be capable of being performed through the central computer but shall be maintained at the PLC. Additional operator interface functions are described under "GRAPHIC DISPLAYS." Software shall be provided to allow the operator to perform control selection, manual control, and acknowledgement function interactively through the screen displays

K. Security Management

1. The software shall provide a user-based password security system to prevent unauthorized personnel from access to system operations. The security system must allow for the creation of users with certain rights and/or privileges. These rights must include the ability to run any combination or all of the applications in the data acquisition system. The ability to allow or disallow users' access to change values, such as set points and machine-setups, on an individual tag basis, shall be supported.

2. Groups of users, such as operators or supervisors, can be created and granted rights. All users assigned to a group obtain the rights of the group, although they are still tracked by the system by their individual ID. Individual members of a group may also be assigned additional rights.

3. Each person in the group shall be assigned a password and security level. Passwords and users should be able to be randomly selected by the Owner at run-time without interrupting the SCADA System. When an operator logs on, the security access shall be set at the level assigned to that operator.

4. The security system will support either centralized or distributed security file management.

5. The security system shall employ and generate an audit trail that will tag every operator's action with user identification (ID).

a. Security Areas

1) The system must support separate security areas. Security areas shall be assignable on a per tag basis. Each tag can be assigned to all of the available security areas, none of the available security areas, or up to 3 individual security areas. Only users with clearance for those security areas shall have the ability to change parameters.

2) Security area names may be up to 20 characters in length.

b. Security Manager: The following functions must be supported within the security manager application:

1) Enable/Disable user-based security

2) Define users, passwords, and login names

3) Define groups to which users may belong

4) Define security path(s)

5) Define user and/or group rights/privileges

6) Define security area names

7) Define system auto-start user

6. In order to prevent unauthorized personnel from operating an unattended workstation, the security program shall have a "timer" that will automatically log off the authorized logged operator after 15 minutes from the last key stroke or mouse activity.

7. There shall be at least eight (8) security levels, including the minimum levels listed below (lowest to highest). The security levels shall be able to be configured in any combination and also be extended to 16 modes.

   a. View Level: At the view level, an operator shall be able to view all display screens and request reports, but all other available privileges, such as control, configuration, or make any other functional changes to the system, shall be denied/blocked. On initialization, the system shall default to the view level shall be blocked.

   b. Operate Level: At the operating level, an operator shall be able to initiate commands (pump start/stop, etc.) and adjust set points and similar control parameters but shall not be permitted to perform system configuration functions.

   c. Engineer and Supervisor Level: At the engineer or supervisor level, a person shall be able to perform all functions provided for the software. This shall include the setting of operator security levels.

   d. Class Based Security: A class-based security scheme shall be inherent to the system allowing for Multiple View Levels, Operate Levels, and Engineer and Supervisor Levels. This scheme makes it possible for two operators to have the same level but mutually exclusive access to certain functions.

2.4 HMI NODES

A. The CONTRACT DRWAINGS presents the various HMI node types. A summary description of each node is provided below.

B. Historian

1. The Historian server shall collect and archive data that is passed from the SCADA I/O server. The Historian shall examine the data received and compares against predetermined archive requirements (e.g., priority, preset sampling period, collection offset deadband, exception deviation since last read, etc.) prior to data archival. The Historian serves as data source for trending applications and reporting functions which may be integral to the Historian application or a separate reporting software module.

2. The historian shall provide multi-level and synchronized historical data collection systems and authorized domain user access flexibility. The collection task can be run at any one or more computers on the network. The task shall have the ability to access data from the memory-resident tag list on its own computer and/or any computers on the network.

3. All status changes and operator inputs shall be stored in the Historian for historical record keeping. The record shall include the time of occurrence, the point identification, the status/alarm (or return to normal) message, the present value for analog alarms, and the previous and entered value for parameter changes. Provisions shall be made to maintain at least 1,000 records.

4. For a system that has a Historian at multiple locations (e.g., plants and headquarters, etc.), collected data is passed from the low hierarchy of Historian to a higher-level Historian.

5. The Historian shall communicate to the SCADA I/O Server using OPC communication protocol (continuous update).

6. The data synchronization between the I/O server and the Historian synchronization should occur in parallel with the real-time data collection. In cases where a system has more than one Historian, Historian to Historian synch, the data synchronization should commence immediately but re-prioritized during scheduled update periods per vendor's recommendation.

7. Historian shall have scalable fault-tolerant storage and redundant OPC communications to support redundant local SCADA I/O server arrangements (i.e., the local Historian will automatically establish communications with the active (primary) SCADA I/O server)

8. The Historian must be capable of receiving out-of-synchronization data and re-ordering for storage in chronological order.

9. The Historian shall include a default MS Excel link to support minimum reporting capability. However, a more robust, OPC compliant, web-capable reporting application should be implemented to support enterprise level inter-operability.

10. Historian server should be configured to support web-based clients.'

11. In the event of communication loss, the following Historian functions should be available

    a. Loss of communications (following a pre-set number of failed retries) should result in generation of a low-level system alarm

    b. In the event of storage overflow at the SCADA, I/O server, the earliest data written should be the first to be overwritten.

    c. Upon recovery of the storage Historian and its communication module, communication should be automatically established to all data sources and systematic query and data synchronization executed.

12. Machine Type: Rack-mount multi-processor, RAID 1 multi-drive, server grade computer (spec as recommended by the HMI application software vendor to support the required control screens and I/O density). Application should be stored on the RAID 1 drives with the OS. Collected data should be routed to the scalable NAS (Network Attached Storage) RAID 6 storage device. Additional system backup and appropriate media shall be per Owner's procedures.

C. Dedicated Operator Workstation

1. Function: This workstation shall provide an industrial operator interface with a full or minimal operating system and embedded and limited I/O HMI application and logging capability. The dedicated operator interface should only include control screens, fixed trends, and alarm management functions customized to support a specific package system or equipment grouping.

2. In cases where field control panels include an operator interface, the operator interface may be implemented using a panel-mounted industrial workstation (employing a full OS installation) or ruggedized OS panel display. If used, the operator interface shall be linked to the plant as a client node or configured to independently interface with the local controllers. Where established as a dedicated device, the interface may serve as a primary or only graphic access point for a package system. Devices that cannot be monitored or secured shall not be used.

D. Engineering Workstation

1. Function: The engineering workstation is a programming workstation. It shall be equipped with the HMI software run-time development license for centralized development, modification, and testing of controls screens.

2. The workstation software shall run on MS Windows Pro platform or dependent upon application demands (e.g., network monitoring applications).

3. The Engineering Workstation shall provide the following functions:

   a. Develop, modify, and test graphic control screens, trends, and reports.

   b. Provide access to in-package and extended graphic symbol/object/gif libraries.

   c. Develop, modify, and test HMI level I/O databases (as applicable), functional code, web pages, workflow triggers, and supporting material.

   d. Modify tagging structures, tag groups, alarm groups/definitions, etc.

4. The Engineering Workstation shall be provided with:

   a. PLC programming software and PLC simulation software for testing. Include support for auto PID loop-tuning tools.

   b. Support for server and system monitoring and analysis tools as may be recommended by the HMI vendor.

   c. Control system network monitoring and analysis tools may be recommended by the software manufacturer for troubleshooting and system analysis.

5. Machine Type: Desktop multi-processor, multi-drive, graphic workstation grade computer Application should be stored on Drive 0 with the OS. Application data should be stored on Drive 1.

E. Full Client Workstation

1. Function: Full client workstation is a workstation with HMI client application and custom control screens installed locally. The client workstation shall display and allow authorized operator navigation of control screens with integral signal/status data continuously updated from the active I/O server. The client workstation shall also provide authorized operator access to trending display/ad-hoc development software, reports display/ad-hoc development software and view access to other HMI manufacturer furnished analysis / monitoring tools.

2. The workstation shall provide secure access to all I/O server monitoring/control screens and historical data. Authorized users shall have view access to previously generated and archived reports as well as active trends. However, trend and report development capabilities will be limited to creation of new ad-hoc trends and creation of new ad-hoc report templates for manual generation only. Modification of existing trends and reports shall not be possible from the client's workstation.

2.5 NETWORKING AND DISTRIBUTED OPERATION

A. The intent of these specifications is for the PLC Based Control System to have a distributed client/server system architecture to facilitate a distributed type control system. This architecture shall employ a local area network (LAN) as the method for communicating among network and HMI computer nodes. Each node may be assigned one or more tasks.

B. It is also the intent of these specifications to provide a system which can be easily expanded and reconfigured. Therefore, all changes in system architecture, expansion of I/Os, modifications to and implementation of control strategies shall be easily done on site mainly through downloading.

C. Data shall be available to all computer's nodes and individuals on the network that have been provided access. Real-time data shall be available directly across the network from the computer that acquired it from the process hardware. Configurations that require each computer to contain copies of database tags it needs to access are not acceptable.

D. Configuration and Expansion:

1. The Contractor shall be responsible for configuring the new, and if applicable, the existing network hardware, verifying the firmware, adding communication modules (and other network hardware components as specified) and configuring the network modules to ensure successful working integration with the control system communication network per the contract requirements.

2. The LAN shall comply with the IEEE 802.3 standards for Ethernet and shall operate at a minimum bandwidth of 100Mbps. The network topology shall permit either switched 100BASE-T or 100BASE-TX connections through an auto-negotiating switch.

3. The Contractor shall provide network node IP addressing and node naming conventions (including field network nodes) for all network switches provided as part of this project.

4. Configurations shall provide selective access to functionality, read/write access to the data, and read-only access to all data on the network.

5. The system shall be configured such that the failure of any one computer will not affect the operation of others on the network. It is recognized that data contained in a failed machine will be unavailable to other machines requesting it. However, the system shall offer the provision for re-starting or re-configuring other stations to take over.

6. The system shall provide an on-line installation and configuration program for configuring the various computers and nodes on the network. This configuration program shall allow for assigning unique node names to each computer as well as selecting the functions that the machine will perform.

7. The system will allow additional computers to be added to the network while on-line, without disrupting the operations of the other machines.

8. Client nodes shall have the ability to access multiple servers through the network, one at-a-time or concurrently. Access rights shall be administered from the servers.

9. To minimize network overhead and maximize speed of response, real-time data and any graphics changes shall be passed from server to client on an exception basis. All graphic changes shall be done once at the server level and shall be “broadcasted” globally to all the workstations for the update. The Owner shall not have to update individual workstations after the changes are made on the server.

E. Local Area Network (LAN) Architecture and Use

1. The system shall be capable of supporting the following network configurations:

   a. Network Topology

      1) Ethernet

      2) Token Ring

   b. Network Protocols

      1) TCP/IP

2. The System Supplier shall provide specific details as to the manufacturers and model or version numbers of currently supported topologies and protocols upon request.

3. The system must provide session-oriented communications for data transfer. Each computer station must be capable of establishing up to 100 sessions with other stations.

4. The system must also be capable of running simultaneously with other LAN users who are not operating the data acquisition system software (but who might be using a LAN manager or file transfer software).

5. The application program interface used by all system program modules and by user-written applications shall make MMS-like (Manufacturing Message Specification) Variable Access Service function calls.

F. Error Detection, Diagnostics and Recovery

1. The system shall provide on-line diagnostics that display the current status and operation of the local area network and its nodes. The diagnostic display shall include the LAN adapter status for the machine showing the display, as well as the current number of messages, errors and retries.

2. An additional display shall show the current session status (established, pending, and off-line) of all stations on the network. A session monitor program that automatically monitors and recovers communications shall be supplied with the system.

3. Should network communications errors be detected, the software shall automatically indicate that the data (on graphic displays, in historical files, etc.) is no longer valid and shall replace the invalid data with other characters. The system shall automatically attempt to re-establish communications, and, if successful, shall then replace the characters with valid data. This capability shall be built-in to the software and shall not require any user programming or other user-dependent actions to implement.

G. Network Access

1. On-Line: The system shall have the capability of creating and modifying tags in one node by operating the graphics editor or database builder program in another node. This operation shall be performed on-line, while the destination node is operating. This new or modified tag data shall immediately be available to all other nodes on the network. The security system will restrict access to the database to authorized users.

2. Remote:

a. The remote access server shall be integral to a hard firewall appliance or equal network component to ensure maximum segregation and security. Full Simple Network Management Protocol (SNMP) services shall be used (e.g., monitor and record all login attempts (failed and successful) and monitor/record activities of all users remotely logged-in, etc.)

b. Remote Monitoring and Control shall be available via remote connection. The following functions shall be supported:

1) Viewing graphic displays being updated with real-time data

2) Viewing historical trend data

3) Configuring the database tags throughout the network

4) Copying files from/to the network

5) Starting and Stopping Pumps

6) Opening and Closing Valves

c. Provide Rockwell Factory talk Viewpoint software or equal.

2.6 SOFTWARE TOOLS

A. The system shall be built on and use industry standard development tools.

1. Language: The system must be written predominantly in the C and C++ languages.

2. Data Access

a. The system shall provide an open architecture that allows interaction with other programs. It must provide a mechanism for other programs to access individual data elements and fields (such as the high alarm limit of an analog input) within data elements in real time. File transfer mechanisms are not acceptable; the access must be direct to the memory-resident database.

b. The following shall be supported:

1) DDE. The system must support Microsoft standard Dynamic Data Exchange (DDE) Server and Client functionality to share data with other DDE-aware applications.

2) C/C++. The system shall provide development tools that allow programs written in C or C++ to access (read/write) real-time tag data in the real-time databases on the network.

3) Visual BASIC. The system shall provide development tools that allow programs written in Visual BASIC to access (read/write) tag data in the real-time databases on the network.

2.7 CUSTOMER SUPPORT BY SOFTWARE MANUFACTURER

A. The software manufacture must provide technical support for twenty-four hours, 7 days a week.

B. The Contractor shall register all Rockwell FactoryTalk and Logix Designer software licenses with the Rockwell Automation Software Support Program for the entire construction period plus two years after final acceptance. This support shall include 24/7 technical support (email and phone), software upgrades, and patches at no additional cost. Software support for renewal, as applicable, shall be the sole responsibility of the Contractor. Note: furnished license for the FactoryTalk Gateway / RSLinx Enterprise OPC gateway shall be sized to accommodate all project I/O tags plus 50% growth.

2.8 MANUFACTURERS, OR EQUAL

A. Rockwell FactoryTalk SE

2.9 MISCELLANEOUS UTILITY SOFTWARE

A. Virus Protection: The Contractor shall furnish virus protection software in each workstation and server that is compatible with HMI software (Symantec, or equal).

B. File Backup: Software/tools for automatic and manual file back-up (Arcserve, or equal) on each server shall be provided.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The PLC programming software shall be provided with the PLC hardware as specified in Section 40 95 10 - PLC-Based Control System Hardware.

3.2 FACTORY TEST

A. General: The PLCbased control systems software factory test shall be provided in accordance with Section 40 91 00 - Process Instrumentation and Control Systems.

3.3 PROGRAMMING, TESTING, AND INSTRUCTION

A. General: The PLC SCADA System Software, testing, and instruction shall be provided in accordance with Section 40 91 00 - Process Control and Instrumentation Systems.

3.4 SOFTWARE LICENSE AND REGISTRATION

A. All software provided shall be installed and used within the terms of the software manufacturer's license agreement. All software purchased by the Contractor shall be registered to the Contractor during the construction phase of this project. During that time, the Contractor shall be responsible for providing and incorporating minor software package updates issued by the software manufacturer. For example, if version 3.1 of a program is purchased, and versions 3.2 and 3.3 were released prior to project completion, the Contractor shall be responsible for incorporating these later versions into the final project. The Contractor would not be responsible for incorporating major software revisions such as the release of a version 4.0 or 4.1.

B. Prior to substantial completion of this project, the Contractor shall register all the software packages provided to the Owner and provide the Engineer and Owner with written confirmation of having done so.

3.5 HMI APPLICATION SOFTWARE CONFIGURATION (PROGRAMMING)

A. Graphic Display Configuration

1. It is the responsibility of the Contractor to configure the workstations and to develop, design, engineer, configure, and test all of the graphic displays required for this project. All of this work shall take into account the specific needs of the Owner. The Contractor shall review the Owner's existing displays and sketches if available from the Owner. The Contractor shall bring to the meeting samples of displays from past projects.

2. The Contractor shall provide up to 200 graphic displays for this project, not including controlling pop-up windows or trend graphics.

3. The Contractor shall prepare the appropriate submittals, and their schedule as specified in Section 40 91 00- Process Control Instrumentation Systems

4. In order to facilitate this, work with the Contractor shall conduct the following meetings with the Owner. The Contractor shall allow 2 days for each meeting.

    a. Graphics Meeting No. 1

        1) The Contractor shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and development of the graphic displays. At this meeting, which shall be attended by the Owner, the Contractor shall distribute sample display formats for illustration purposes. As a minimum, this meeting shall address the following issues:

            a) All in- plant and remote site areas and conventions for identifying tag names and descriptors.

            b) An itemization of the type of display to be used at each level in the graphic hierarchy (e.g., preformatted displays, templates, custom graphics, etc.).

            c) Organization of the systems universal display hierarchy.

            d) Paging schemes to be used to enable the movement from one display to another.

            e) Definitions of all display select commands that enable the operator to move within the display hierarchy.

            f) Definition of graphic symbolism to be used on the project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels and valves. All symbolism must be specific as opposed to generic in that shapes must define both function and type (e.g., specific symbols for each valve design, each pump design, each type of flow meter, etc.). If the Contractor‘s library of shapes does not adequately describe plant or system conditions, the Contractor shall develop additional shapes to meet the system requirements. Standard displays will include: open/close, modulating valves, on/off, PID, tanks, etc.

            g) Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms on the basis of alarm priority, background colors, static field colorization, and dynamic field colorization. Color change that indicates change of state of equipment or mode, shall be accompanied by text message. Provide a legend screen(s) in the system to indicate one of each type of equipment symbol and color standard and the meaning of each color. The legend screen shall be accessible from the main menu.

h) Definition of control input commands which enable the operator to interact with faceplates control stations and custom graphic displays to implement control outputs/functions.

i) Definition of data input commands which enable the operator to enter/download numeric values into the PLCs.

j) Definition of control and/or alarm set points display next to its associated analog value or equipment.

k) Any device that has a selectable mode (e.g. auto-manual, local-remote, etc.) either in the field or at the control center, that mode shall be displayed next to its associated device.

l) The utilization of cursor movement commands which enable the operator to move within a display.

m) Definition of the utilization of “poke” points or fields which are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.

n) The utilization of blinking and conditional text.

o) Designation of groups within each process area along with tag names and descriptors.

p) The assignment of individual control loops and inputs to specific groups.

q) A review of graphic generation procedures.

2) Subsequent to the graphics meeting No. 1, the Contractor shall prepare and formalize a document titled “GRAPHICS CRITERIA” which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to. This report shall be supplemented by graphic examples which illustrate the incorporation and application of each graphic criterion. The report shall be submitted as indicated in the submittal requirements in Section 40 91 00 - Process Control and Instrumentation Systems.

b. Graphics Meeting No. 2

1) Subsequent to the finalization of the overall systemwide graphics criteria, the Contractor shall develop graphic packages for all of the workstations being furnished under this project. At this meeting, the Contractor shall submit the number of copies specified in Section 40 91 00 – Process Control and Instrumentation Systems - including:

a) A review of the graphic package developed for the process areas for content and completeness.

b) A review of all data fields that display automatically updated process information.

c) A review of all required input commands associated with the graphic access and control manipulation.

B. Graphic Displays Layout and Style:

1. The style and symbols of all the graphic displays shall be uniform. Similar facilities shall have a uniform layout. The graphic display of each facility/site shall be a diagrammatic presentation of the equipment and the piping system of the facility including the suction and discharge piping, with the proper captions.

2. As a minimum, the following graphic displays shall be developed for this project (as minimum):

a. Plant process overview display, or, if applicable, water distribution and remote sites overview display.

b. All processes including all existing interfacing to the PCIS of this project. For remote sites, a station graphic display with a control screen shall be configured. This shall include symbols for pumps, valves, alarm symbols, and operational data.

c. PCIS network and nodes

d. All group alarms display.

e. All control loop tuning displays.

f. All analog faceplate displays with graduation of engineering unit values.

g. All custom displays for operators to enter set points and recipe displays.

h. All key macro icons display.

i. All database archiving control displays.

j. All historical trending displays.

k. Control system network configure and diagnostic.

l. Communication status and diagnostics display(s)

m. Redundant communication diagnostic and control.

n. Redundant master nodes diagnostic and control.

o. All local nodes are diagnostic (including PLC's, Operator Interfacing Units, and Instruments).

C. Control, Monitoring and Alarm Configuration

1. For equipment that is controllable from the PLC in either a MANUAL or AUTOMATIC mode, the operator shall be provided with a software “AUTO-MANUAL” selector switch at the operator HMI workstation. Transfer between the

MANUAL and AUTOMATIC modes shall be bumpless. This switch is functional only when the LOCAL-OFF-REMOTE switch in the field is in REMOTE position. The following are the AUTO- MANUAL functions:

a. AUTO – In this position, the operator delegates and enables the control of the equipment to be performed at the PLC/control panel. A control mode status signal (AUTO) shall be sent from the workstation to the PLC to indicate when the PLC is allowed to control the equipment.

b. MANUAL – In this position, the operator bypasses/overrides the control functions in the PLC and manually controls the equipment from the HMI. In this position, a software switch, such as “START-OFF STOP” or “OPEN-STOP-CLOSE” or manual control of the equipment is enabled as described below.

c. A second software switch such as “START-OFF-STOP” or OPEN-STOP-CLOSE,” etc. or as required by the application, shall be provided in the HMI to control the equipment in the field manually from the HMI. Variations of these types of control switches shall be provided for the equipment based on its control application. These switches shall be functional only when the above “AUTO-MANUAL” switch is in “MANUAL” mode.

2. The PLC shall monitor the local control mode status switch (LOCAL-OFF-REMOTE) and attempt to control only that equipment which is in the REMOTE mode.

3. Operator Settings: Operator set or entered values shall be constants that are adjustable or set from operator displays. Specific values that are required to be operator set are noted in the process control strategy descriptions.

4. Tunable Values: Tunable values are constants that are adjustable at engineer level displays without requiring any software reconfiguration. These values are not adjustable from operator level displays. Tunable time shall initially be set at 10 seconds.

5. All analog and discrete inputs to the PLC shall be displayed. Both RUNNING and OFF input states shall be displayed

6. Set point, process variable, and controller output shall be displayed.

7. When equipment is tagged OUT OF SERVICE by the operator, all associated equipment shall have their alarms inhibited until the tagged equipment is re-tagged IN SERVICE.

8. All PID control functions (P, PI, and PID) shall be provided with standard analog controller functions and operator interfaces including, but not limited to, the following: Provisions shall be included to prevent reset windup.

a. AUTO-MANUAL mode selection: In AUTO, the output of controller shall be based on the PID control calculation. In MANUAL, the output of the controller shall be operator adjustable. Transfer between operational modes shall be bumpless.

b. LOCAL-OFF-REMOTE set point selection: In LOCAL, the set point shall be operator adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.

9. Motor Protection Relays – All information, including but not limited to: Phase Voltages, Kilowatts, Kilovars, Power Factor, and Frequency shall be monitored and trended.

10. Power Monitoring - All information, including but not limited to: Phase Voltages, Phase Amps, Kilowatts, Kilovars, Power Factor, and Frequency, shall be monitored and trended.

11. All chemical feeders shall be immediately restarted following restoration of power – either from the utility or the generator.

12. Soft I/O: Software derived I/O points are internal I/O points developed to provide for the necessary functionality typically in the PLC or HMI programming and not from physical equipment or hard wired I/Os. The Soft I/O shall be viewable and/or adjustable from the HMI. The Contractor shall provide whatever additional required software I/O is to achieve the functional descriptions and the control strategies listed in Section 40 90 10 – Control Strategies at no additional cost to the Owner. Soft I/O are identified in the I/O List in Appendix X.

D. Data Collection: The Contractor shall provide programming that collects current values of specified variables from online data storage areas, statistically manipulates data, and creates and maintains a historical data base of collected values. Statistical manipulation shall include linear averaging, filter averaging, and noting of "bad" values. Statistically manipulated data shall then be stored in a historical database.

1. The frequency of historical collection shall be selectable between once per second to once per month. The type and quantity of historical data shall be selectable by addition and deletion to/from the historical data base.

2. The Contractor shall provide adequate online storage to retain 60 days of 6-minute average values for 2,000 variables and hourly maximum, minimum, and average values of 2,000 variables.

3. The Contractor shall provide adequate online storage to retain 2 years of daily average values for 2,000 variables and monthly maximum, minimum, and average values for 2,000 variables.

4. Historical records (daily) shall be scheduled to be transferred automatically to a mass storage device.

E. Reports

1. General: The Contractor shall provide all the reports associated with this project. The reports shall take into account the specific need of the Owner incorporating any existing reports now being used by the Owner.

2. In order to facilitate this, the Contractor shall conduct the two (2) meetings with the Owner.

3. Report Meeting No.1: The first meeting will be a criteria meeting that shall address the following issues and develop criteria that shall be adhered to in the configuration and development of the reports. Subsequent to the meeting, the Contractor shall implement the information obtained in the meeting and generate all the required reports and submit a “REPORT CRITERIA.” The report shall be similar in nature to the GRAPHICS REPORT. The submittal contents, number of set and submittal schedule shall be in accordance with Section 40 91 00 – Process Control and Instrumentation Systems. As a minimum, the following criteria shall be developed:

    a. Review of samples of existing reports that the Owner may have. The Contractor shall bring to the meeting samples of display from past projects.

    b. Organization of the system universal report categories.

    c. Itemization of the type, titles, and schedule (daily, monthly, yearly) of reports required.

    d. Definition of terms and engineering units to be used in the reports.

    e. Definition of report commands that enable the operator to move within the report editor.

    f. Definition of data input commands enable the operator to enter numeric values into the system.

    g. Scheduled and on-demand reports.

    h. Ad hoc reports.

    i. A review of the report generation procedure.

4. Report Meeting No. 2: Subsequent to the finalization of the report format criteria, the Contractor shall develop report packages for review. At this meeting, the Contractor shall submit the number of copies specified in Section 40 91 00 – Process Control and Instrumentation Systems, including:

    a. A review of the report package developed for the process area(s) for content and completeness.

    b. A review of all data fields for process information.

    c. A review of all required input commands associated with the report access and control manipulation.

5. Process and Production Reporting: The reporting package shall use the process database to provide historical records for an average of 1,000 selected variables. The software as a minimum shall automatically print periodic process and production reports as follows:

    a. Periodic reports: Process periodic reports shall include:

        1) A daily report, which contains hourly information.

2) A weekly report, which contains daily information.

3) A monthly report, which contains daily information.

4) An annual report, which contains monthly information.

6. Maintenance Milestones Reports: For each device for which running information is accumulated, maintenance milestones and reports shall be provided. Whenever the running time and number of starts registers are increments, the milestone registers shall be decremented. As the milestone registers pass zero (indicating maintenance due), decrementing shall continue and display or print out. Decrementing shall continue until the milestone is reset by the operator upon completion of the required maintenance.

F. Trends:

1. The Contractor shall provide time-dependent (24-hours, 7-days, etc.) real time trends for analog variables (e.g., pressure, level, flow, etc.). During the graphic display meetings, the Owner will determine which analog variables will be integrated into a single trend.

2. Generally, each trend display shall not have in it more than 4 variables per trend display, and each variable shall have its own actual engineering unit vertical scale (no common 0-100% scale), and the x-axis shall be the time scale. The system shall have a trend menu to allow the operator to select trend groups for display as well as real time and historical trends. The operator shall be able to save or print a trend display.

3. The real time trend shall display current values. If the historical trends are selected, the software shall retrieve the historical data for each variable and display it for the date and the duration selected.

3.6 OPERATIONAL AND FUNCTIONAL PERFORMANCE

A. Scan Rates: The SCADA system shall be capable of scanning the remote PLCs that communicate over radio within 40-seconds for a complete cycle, based on the following criteria:

B. Data Update Times: Data received from PLCs shall be displayed on the operator consoles (assuming displayed screen contains such data) within one (1) second of receipt of such data at the central computer, regardless of originating PLC, state of the data received, or the number of stations that require the data. Operator entered command or data change shall be transmitted to the PLC within one (1) second of being entered by the operator.

C. Screen Displays: Any specified screen display (except trend displays) shall be drawn complete on any furnished monitor, including all real-time data, within three (3) seconds from an operator's request for the display.

D. Trend Displays: Any specified trend display (up to three trend lines and any time interval, both real-time and historical) shall be drawn complete on any monitor within five (5) seconds from an operator's request for the trend display.

E. Reports: Any specified report shall be compiled and printing initiated on any furnished printer from an operator request for the report.

3.7 TRAINING

A. The Contractor shall provide the Owner with system maintenance and operator training courses on the subjects of use, maintenance, operation, troubleshooting of the components of the PBCS software. The training shall be specifically tailored to this project and reflect the system software installation and configuration. All training shall be conducted on site unless another location is approved by the Engineer and Owner. PBCS software training subjects and the allocated hours for each class shall be in accordance with Section 40 91 00 – Process Control Instrumentation Systems.

B. The Contractor shall provide a qualified instructor for all the instrumentation, control, SCADA, communication, and computer monitoring and control systems furnished for this project.

END OF SECTION

SECTION 43 07 00 – PROCESS PIPING AND EQUIPMENT INSULATION

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide pipe and equipment insulation, complete and in place, as indicated in accordance with the Contract Documents.

B. In addition to the insulation indicated, the Contractor shall insulate exposed cold or hot piping and exhausts that could be hazardous to personnel upon contact.

1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Federal Specifications

HH-1-558B	Insulation Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type)

C. Commercial Standards

ASTM C 547	Mineral Fiber Pipe Insulation
ASTM E 84	Test Method for Surface Burning Characteristics of Building Materials

D. Reference Specifications

1. 01 33 00 – Submittal Procedures
2. 26 05 50 – Electric Heat Tracing
3. 40 05 01 – Piping, General

1.3 CONTRACTOR SUBMITTALS

A. Submit complete Shop Drawings of thermal insulation, with manufacturer's data on materials, covering, jackets, and finish, in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Furnish the following certifications:

1. Certification from the heating system manufacturer that the insulation has been installed in accordance with the manufacturer's recommendations.
2. Certification from the acoustic insulation/duct lining manufacturer that the lining has the indicated sound absorption coefficients.

C. Submit manufacturer’s installation instructions.

D. Submit manufacturer's certificate indicating installer's qualifications.

E. Where insulated pipe is also heat traced, refer to Section 26 05 50 – Electric Heat Tracing, for other submittal requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Insulation material containers shall be marked by Manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Components of the insulation, including covering, mastics, and adhesives, shall have a flame-spread rating of not greater than 25 and a smoke development rating of not greater than 50.

B. Ratings shall be as established by tests in accordance with ASTM E 84, and the above federal and commercial specification standards.

C. Insulation shall be applied in strict accordance with the manufacturer's instructions.

2.2 BASIC MATERIALS

A. Insulation shall be provided for the following, with minimum insulation thickness as indicated:

Pipe		Minimum Thickness of Insulation (inches)
Compressed air piping exposed to the weather	all sizes	1
Raw Water and Filtered Water Pipelines, Chemical Pipes, Drain Pipes, and Sample Pipes	3-inch and smaller	1
	4-inch and larger	1-1/2

2.3 PIPING INSULATION

A. Except as indicated otherwise, piping shall be insulated with heavy density, unfaced, fiberglass pipe insulation.

B. Pipe insulation shall have an average density of 4 pounds per cubic foot or greater, and its conductivity (k) shall not exceed 0.23 BTU-inch per (hour) (square foot) (degree F) at a mean temperature of 75 degrees F.

C. Supporting Hangers

1. For 3-inch piping and larger, the insulation shall be protected at supporting hangers by the suitable hollow steel protection saddles, filled with loose glass fiber insulation as indicated.

2. For piping smaller than 3-inch, place 1/16-inch thick sheet metal shims between the insulation and the supporting hanger; the shim shall be at least 6 inches long.

3. The insulation shall be oversized for installation over electric heating cable.

4. The insulation shall have a factory-applied white fire-retardant vapor-barrier jacket of kraft paper and aluminum foil laminated together and reinforced with fiberglass yarn.

5. Fittings and valves shall be covered with the same insulation material as the pipe, cut in segments to fit snugly without open spaces, held in place with copper wire or cement, and then covered with the same jacketing material as the pipe.

6. Insulated fittings adjacent to vapor-barrier insulation shall be sealed with an acceptable vapor-barrier cement before installation of the finish jacket.

7. The pipe insulation and vapor-barrier shall be continuous through hangers and supports.

8. Where insulation is indicated for the top-half segment of pipe, insulation at support locations shall be of the same density.

9. The bottom-half insulation segments provided between the pipe and the insulation protection shields shall have a density of not less than 6 lb/cu ft.

D. Jacketing

1. A final covering of the insulation for piping shall be of 0.030-inch thick PVC or equivalent strength smooth aluminum, preformed jacketing with a factory-attached moisture barrier.

2. Valves, flanges, fittings, and ends of insulation shall be covered with a pre-molded, precision-formed, high-low temperature PVC fitting cover or end cap, or equivalent preformed unit to match the piping insulation jacket.

3. The pre-molded covers shall be sized to receive the same thickness of insulation as used on the adjacent piping, and shall be sized to cover and protect the insulated fitting.

4. Joints shall be sealed with silicone mastic or solvent welding to provide a continuous air- and weather-tight joint.

5. Strapping shall be 1/2-inch wide, Type 3003 aluminum or stainless steel.

6. Pre-molded fittings shall be **Zeston 2000 PVC**, or equal.

E. Standard Temperature Insulation

1. Standard temperature insulation shall be used for process, cold and hot water, steam, and condensate piping and equipment with surface temperatures up to 850 degrees F.

2. Pipe insulation and jacketing shall be applied to piping where indicated, including associated fittings, flanges, and valves.

3. Pipe insulation shall consist of a molded-type pipe covering, constructed of fibrous glass with a minimum k-factor of 0.23 at 75 degrees F mean temperature.

F. Manufacturers, or Equal

1. Armstrong Contracting and Supply Corp.

2. Certain-Teed Corporation

3. Johns Manville

4. Owens-Corning

5. P.P.G. Industries, Inc.

PART 3 -- EXECUTION

3.1 GENERAL

A. Insulation and liners shall be installed by a qualified insulation contractor in strict accordance with the manufacturer's recommendations.

B. Examination

1. Examine conditions for compliance with requirements for installation affecting performance of insulation application.

2. Verify that systems and equipment to be insulated have been tested and are free of defects.

C. Preparation

1. Clean and dry surfaces to receive insulation.

2. Coordinate insulation installation with the trade installing heat tracing, where applicable. Comply with requirements for heat tracing that apply to insulation.

3.2 PIPING INSULATION

A. Piping, fittings, and valves to be insulated shall be clean and dry prior to installation of insulation.

B. Piping indicated to be insulated shall be completely insulated inside structures, except where indicated otherwise.

1. Damaged Insulation

a. The Contractor shall replace insulation that has been damaged or removed by modifications to the existing piping.

b. The replacement insulation shall be new and joints between new and existing insulation shall be made water-tight.

3.3 FIBERGLASS INSULATION

A. Fiberglass insulation shall be securely held in place before the final covering is applied.

B. A scrim fabric, similar to a 20 x 10 thread count mesh and 100 percent fiberglass, shall be pasted in place to hold the pipe insulation securely to the pipe.

C. The scrim fabric shall be at least 4-inches wide, with at least 2 applications per length of pipe insulation, and one at each joint.

3.4 JACKETING

A. Joints shall be neatly finished with no ragged ends.

B. When finished, the covering shall show no exposed staples or other binding used during installation.

C. Staples, if used, shall be stainless steel.

3.5 LAGGING FABRIC

A. The final lagging fabric shall be neatly pasted in place with a 3-inch longitudinal overlap using a **Luben No. 9** adhesive, or equal.

B. Each transverse joint shall have a 3-inch butt strip of the same fiberglass fabric.

C. Final joints shall be neatly finished with no ragged ends and the covering shall present a neat, uniform surface when finished.

D. The fabric shall show no exposed staples or other binding used during construction; staples, if used, shall be stainless steel.

3.6 COMPRESSION COUPLINGS AND EXPANSION JOINTS

A. The rigid insulation blocks shall be held in place with stainless steel bands, approximately 1/2 inch wide by 0.015 inch thick.

B. After banding, the blocks shall be finished with a trowel coat of insulating cement to filling voids, and troweled to a smooth, neat finish.

C. The installation shall then be covered with an acoustical insulation consisting of a fiberglass fabric weighing 24.6 oz. per sq yd, and coated with a loaded vinyl weighing 83.4 oz. per sq yd.

D. The acoustical insulation shall be **Alpha-Sonic Style No. 75**, or equal.

E. The acoustical insulation shall be covered with a 100-percent fiberglass lagging fabric as indicated.

END OF SECTION

SECTION 43 21 00 – PUMPS, GENERAL

PART 1 -- GENERAL

1.1 SUMMARY

A. Provide pumps and pump systems appurtenances, complete and operable, as indicated in accordance with the Contract Documents.

B. The provisions of this Section shall apply to pumps and pumping equipment throughout the Contract Documents, except where otherwise indicated.

C. The requirements of Section 46 10 00 – Equipment General Provisions, apply to this Section.

D. Unit Responsibility

1. The pump manufacturer shall be made responsible for furnishing the pumps and drives; motors, engines, gears and Variable Frequency Drives (VFDs) as one package and for the coordination of design, assembly, testing, installation, and startup of the Work of each specific pump Section.

2. The Contractor shall be responsible to the Owner for compliance with the requirements of each specific pump Section.

E. Single Manufacturer

1. Where 2 or more pump systems of the same type or size are required, provide pumps produced by the same pump manufacturer.

2. Where multiple pumps are of the same size and type, all parts shall be interchangeable and fit including spare parts.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Abbreviations and Acronyms

1. NPSHr - Net Positive Suction Head Required

2. VFDs - Variable Frequency Drives

C. Reference Specifications

01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
01 60 00	Products, Materials, Equipment, and Substitutions
01 75 00	Equipment Testing and Plant Startup
01 77 00	Project Closeout
01 79 00	Owner Staff Training
05 50 00	Metal Fabrications
09 96 00.10	High-Performance Coatings
Division 26	Electrical
26 29 23	Variable Frequency Drive Units
40 05 01	Piping General
40 73 00	Pressure, Strain, and Force Measurement
40 90 10	Control Strategies
40 91 00	Process Control and Instrumentation Systems
Division 43	Material Handling Equipment as specified by the Project
46 10 00	Equipment General Provisions

C. Reference Standards

American Society of Mechanical Engineers (ASME)	
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings
ASME B16.5	Pipe Flanges and Flanged Fittings
ASTM International (ASTM)	
ASTM A 36	Medium Carbon Steel for fabricated steel bases
ASTM A 48	Gray Iron Castings
ASTM B 148	Standard Specification for Aluminum-Bronze Sand Castings
ASTM A 276	Hot Rolled Annealed and Pickled Stainless Steel Shafts
ASTM A569/AISI 1018, 1020	Low Carbon Steel Shaft
ASTM A569/AISI 1045	Medium Carbon Steel Shaft
ASTM A705	Age-Hardening Stainless-Steel Forgings
ASTM B148	Aluminum Bronze Sand Castings
ASTM B140	Copper-Zinc-Lead (Red Brass or Hardware Bronze)
ASTM B 584	Standard Specification for Copper Alloy Sand Castings for General Applications

International Organization for Standardization (ISO)	
ISO 9000	Quality management systems - Fundamentals and Vocabulary
ISO 9001	Quality management systems – Requirements.
ISO 1940-1	Mechanical Vibration – Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances
American National Standards Institute /Hydraulic Institute (ANSI/HI)	
ANSI/HI 3.1- 3.5	Rotary Pumps for Nomenclature, Definitions, Application and Operation
ANSI/HI 3.6	Rotary Pump Tests
ANSI/HI 4.1- 4.6	Sealless, Magnetically Driven Rotary Pumps for Nomenclature, Definitions, Application, Operation, and Test
ANSI/HI 5.1- 5.6	Sealless, Rotodynamic Pumps for Nomenclature, Definitions, Application, Operation, and Test
ANSI/HI 6.1-6.5	Reciprocating Power Pumps for Nomenclature, Definitions, Application, and Operation
ANSI/HI 6.6 -	Reciprocating Pump Tests
ANSI/HI 9.1 – 9.5	Pumps General Guidelines
ANSI/HI 9.6.1	Rotodynamic Pumps – Guideline for NPSH
ANSI/HI 9.6.2	Rotodynamic Pumps for Assessment of Applied Nozzle Loads
ANSI/HI 9.6.3	Rotodynamic Pumps – Guidelines for Operation Regions
ANSI/HI 9.6.4	Rotodynamic Pumps - Guidelines for Vibration Measurements and Allowable Values
ANSI/HI 9.6.6	Rotodynamic Pumps - Guidelines for Pump Piping
ANSI/HI 9.6.8	Rotodynamic Pumps – Guidelines for Dynamics of Pumping Machinery
ANSI/HI 9.8	Rotodynamic Pumps for Pump Intake Design
ANSI/HI 11.6	Rotodynamic Submersible Pumps for Mechanical and Electrical Acceptance Criteria
ANSI/HI 14.1-14.2	Rotodynamic Pumps for Nomenclature and Definitions
ANSI/HI 14.3	Rotodynamic Pumps for Design and Application
ANSI/HI 14.6	Rotodynamic Pumps for Hydraulic Performance Acceptance Test
ANSI/HI 40.6	Methods for Rotodynamic Pump Efficiency Testing
National Sanitation Foundation/American National Standards Institute (NSF)	
NSF/ANSI 61 -	Drinking Water System Components – Health Effects

1.3 SUBMITTALS

A. Product Data

1. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit pump name, identification number, and specification Section number.

2. Submit performance data curves showing head, capacity, horsepower demand, NSPHr3 required, and pump efficiency over the entire operating range of the pumps. Submit efficiency curves of motors and VFDs.

    a. Require the manufacturer to indicate the limits on the performance curves recommended for stable operation without surge, cavitation, or excessive vibration.

3. Submit assembly and installation drawings, including shaft size, seal, coupling, bearings, anchor bolt plan, part nomenclature, material list, outline dimensions, and shipping weights.

4. Submit Rotodynamics and Structural Analysis as specified in Part 2 – Products.

5. Submit material testing procedures and Test Certificate as specified in Part 3 – Execution.

6. Anchorage calculations and required documentations.

7. Submit electric motor data.

8. Submit a wiring diagram of field connections, with identification of terminations between local control panels, junction terminal boxes, and equipment items. Submit a complete electrical schematic diagram.

9. Submit factory performance and functional test plan as specified in Part 3 – Execution.

10. Submit Certificate of Inspection after receipt of shipment at job site.

11. Submit Certificate of Installation as specified in Part 3 – Execution.

12. Submit Certificate of Inspection after completion of Operational Readiness Testing as specified in Part 3 – Execution.

13. Submit Plant Operation and Maintenance Training Lesson Plan and schedule as specified in Part 3 – Execution.

14. Submit Certificate of Successful Trial Functional Dry Testing as specified in Part 3 Execution.

15. Submit Procedure for Equipment Testing and Plant Startup as specified in Section 01 75 00 – Equipment Testing and Plant Startup.

16. Submit Certificate of Successful Final Performance Verification and Functional Wet Testing as specified in Part 3 - Execution.

C. Technical Manual

1. Submit a Technical Manual containing the required information indicated in Section 01 33 00 – Submittal Procedures, Section 01 73 00 - Installation, Operation, and Maintenance Manuals, and each specific pump Section.

D. Spare Parts List

1. Submit a spare parts list containing the required information indicated in Section 01 33 00 – Submittal Procedures and each specific pump Section.

E. Factory Test Data

1. For pumps that shall be factory witness tested, submit layout drawing of factory test setup showing the pump, drive, piping diameter and lengths, locations of valves, instruments and test procedures and valid calibration certificates of test instruments.

2. Submit signed, dated, and certified factory test data for each pump system. No equipment shall be shipped until the test data have been approved by the Engineer.

F. Certifications

1. Submit the manufacturer's certification of proper installation.

2. Submit the Contractor's certification of satisfactory field testing.

3. Certificate of Factory Performance Test by manufacturers for pumps, motors, and VFDs.

4. Certificate of proper installation of pump system signed by the Manufacturer and Contractor.

5. Certificate of field affirmation performance testing signed by the Manufacturer and Contractor.

6. Certificate of successful startup and commissioning signed by the Contractor and witnessed by the Engineer.

G. Delegated Design Submittals

1. If required by the specification Section, submit Lateral, Torsional and Structural analysis analyses signed by registered professional engineer.

H. Test and Evaluation Reports Submittal

1. Factory performance test report for pumps, motors and VFDs.

2. Shaft material mill certificate and casting material testing report if required in each specification Section for large pumping equipment.

3. Nondestructive Testing procedures and certificate of materials report if required in each specification Section for large pumping equipment.

I. Manufacturers' Instructions

1. Equipment handling, shipping and storage instructions by manufacturers.

2. Installation instructions by manufacturers.

3. Startup and commissioning instruction by manufacturers.

J. Source Quality Control Submittals

1. Foundry casting quality control documents if required in equipment specification section for large pumping equipment.

2. Source quality documentation of shafting if required in equipment specification section for large pumping equipment.

3. Statement by manufactures indicating adherence to quality procedures per ISO 9001.

K. Manufacturer Reports

1. Submit manufacturer’s production schedule and report, if required in equipment specification section.

2. Submit manufacturer’s factory testing report for all pump system equipment.

3. Submit field vibration testing report conducted by the Contractor and Manufacturer and witnessed by the Engineer.

L. Qualification Statements

1. Submit resume of specialist engineer who will perform torsional, lateral and structural analysis.

2. Submit resume of factory trained installation and start-up representative.

1.4 CLOSEOUT SUBMITTALS

A. Submit closeout documents specified in Section 01 77 00 – Project Closeout.

B. Operation and Maintenance Data

1. Submit Operation and Maintenance Manuals necessary for the work as part of process equipment provisions. Include video when required for Owner’s instructions.

C. Warranty Documentation

1. Submit final executed warranty documents for pumping equipment.

D. Record Documentation

1. Submit record drawings and specifications of record documentation specific to include items such as annotated drawings, Project Manuals, and submittals and samples, marked up to indicate the actual products used and locations of concealed work or utilities. This may include periodic or final update of a Building Information Model (BIM) by the Contractor.

E. Software

1. Submittal of copy of all operating system and other utility software necessary to operate and maintain the software during the expected life of the product.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts

1. In addition to the list of spare parts listed in each pump specification Section, include list of recommended spare parts, name, part number, number of units, cost and source location, address, contact names and phone numbers.

B. Tools

1. Submit list of tools specified in each Section.

2. Submit list of recommended tools and cost for use to maintain equipment.

3. Submit list of special tools unique to the equipment supplied in the project.

1.6 QUALITY ASSURANCE

A. Regulatory Agency Sustainability Approvals.

B. Submit Quality Assurance procedures applicable to foundry, machine shop, testing, handling, delivery, installation, and startup.

C. Qualifications

1. Submit resume of manufacturer representative proposed to supervise field installation and startup.

2. Submit resume of manufacturer representative who will conduct operation and maintenance training of Owners Operation and Maintenance personnel.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Delivery, storage and handling shall conform to the requirements of Section 01 60 00 - Products, Materials, Equipment, and Substitutions.

2. The Equipment shall be shipped and stored on site until time of installation per manufacturer's requirements.

3. Any corrosion in evidence or damage to the coatings shall be repaired to the satisfaction of the Engineer.

B. Storage and Handling Requirements

1. Care shall be taken in loading, transporting and unloading to prevent injury to the pumps, drives and appurtenances, or coatings. Equipment shall not be dropped. All pumps and appurtenances shall be examined before installation and no piece shall be installed which is found to be defective. Any damage to the coatings shall be repaired to the satisfaction of the Engineer.

2. Prior to shipping, the ends of all equipment shall be acceptably covered to prevent entry of foreign material. Covers shall remain in place until after installation and connecting piping is completed.

3. Special care shall be taken to prevent pumps, drives and appurtenances from being directly exposed to the sun, or exposed to extremes in temperature. See the manufacturer's information for further requirements.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Compliance with the requirements of the specific pump Sections may necessitate modifications to the manufacturer's standard equipment.

B. Performance / Design Criteria

1. Capacities

a. Provide centrifugal pumps with a continuously rising pump curve, or with a pump curve that does not cross the system curve within the pump curve’s “dip region.”

b. Unless otherwise indicated, the required shaft horsepower for the entire pump assembly at any point on the performance curve shall not exceed the rated horsepower of the motor or engine or encroach on the service factor.

c. For VFD driven pumps, the rated horsepower of the selected motor shall be 110 percent of the maximum brake horsepower required by the pump.

2. Compatibility

a. Provide entirely compatible components of each pump system provided under the specific pump Sections.

b. In each unit of pumping equipment, incorporate compatible components such as, couplings, electric motors or engine drives, variable speed controls, necessary mountings, and appurtenances.

3. Balancing

a. Unless otherwise specified the rotating assembly shall be dynamically balanced to ISO 1940 G 6.3. Submit Balancing certificate including balancing test procedure and test results.

2.2 OPERATION

A. General pump systems operation and controls shall be as described in each pump system specification section and in Section 40 90 10 – Control Strategies.

B. Process Controls shall be as indicated on the Process and Instrumentation diagram drawings and as described in Section 40 90 10 – Control Strategies.

C. Detailed modes and sequence of operation shall be as described in Section 40 90 10 – Control Strategies.

2.3 MATERIALS

A. Provide materials suitable for the intended application.

B. For materials not indicated, provide high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended, and conforming to the following requirements:

1. For drinking water service, use materials with weighted average of lead content of wetted components not to exceed 0.25% to meet the requirement of the Reduction of Lead in Drinking Water Act.

2. Bowls and Casings

a. Provide cast iron pump casings constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal. Unless otherwise indicated on the specific pump sections, cast iron-fitted pumps shall be epoxy lined and coated for better efficiency.

3. Impellers

a. Where individual pump sections indicate cast iron impellers, such impellers shall be epoxy coated and constructed of close-grained gray cast iron, conforming to ASTM A 48 - Gray Iron Castings, Class 30, or equal.

b. Where individual pump sections indicate stainless steel impellers, such impellers shall be constructed of Type 316 stainless steel.

c. Where individual pump sections indicate bronze impellers, or where the impeller material is not otherwise specified, such impellers shall be constructed of zero-lead aluminum bronze conforming to ASTM B 148 – Aluminum-Bronze Sand Castings, or zero-lead, zinc less nickel aluminum bronze ASTM B 148-C95800.

4. Provide pump shafts constructed of Type 416 or 316 stainless steel.

5. Provide anti-friction bearings or zero-lead bronze bearings. Bronze bearings shall be Bismuth Tin Bronze ASTM B 584 C89835, or equal.

6. All elastomeric materials such as gaskets, seals, O-rings in contact with water with chloramine and ozone shall be Teflon, Viton-A or other materials compatible with the fluid service. Test certificate from a material testing laboratory to provide proof of test shall be made available to the Engineer if requested.

7. Miscellaneous stainless-steel parts shall be of Type 316.

8. Provide anchor bolts, washers, and nuts in standard service (non-corrosive application) of galvanized steel in accordance with the requirements of Section 05 50 00 – Metal Fabrications.

9. Provide anchor bolts, washers, and nuts in corrosive service of stainless steel in accordance with Section 05 50 00 – Metal Fabrications.

C. Materials in contact with potable water shall be listed as compliant with NSF Standard 61. Test certificate from a material testing laboratory to provide proof of test shall be made available to the Engineer if requested.

D. Assembly and Fabrication

1. Factory/Shop Assembly/Fabrication

a. Equipment shall be shop fabricated at a factory in accordance with manufacturer's instructions, or industry standard, etc…) to obtain a level of quality meeting the requirements of the CONTRACT DOCUMENTS.

2. Assembly and Fabrication Tolerances

a. Equipment shall be assembled in accordance with manufacturer's instructions, or industry standard, etc…) to obtain a level of quality meeting the requirements of the CONTRACT DOCUMENTS.

b. Equipment tolerances shall be established and followed to obtain a level of quality meeting the requirements of the CONTRACT DOCUMENTS.

E. Concrete Pump Foundation and Grout Mixes

1. Equipment concrete foundation and mixes shall be in accordance with Section 03 30 00 - Cast-In-Place Concrete. Concrete and grout mixes shall be specifically designed for the intended application and installed in accordance with the manufacturer's recommendations, free of voids/perforations that may affect the pump operation.

F. Finishes/Coatings

1. Primer Materials

2. Finish Materials

3. Shop Finishing Methods

2.4 ACCESSORIES

A. Flanges and Bolts

1. Provide suction and discharge flanges conforming to ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, or ASME B16.5 - Pipe Flanges and Flanged Fittings dimensions. Pressure class shall be suitable for the application or as otherwise recommended by the pump manufacturer.

2. Provide flange bolts in accordance with the requirements of Section 40 05 01 – Piping General.

3. Flange gaskets shall be in accordance with Section 40 05 01 - Piping General.

B. Lubrication

1. Vertical pump shafts for clean water pumps shall be product water-lubricated, unless otherwise indicated.

2. Provide deep-well pumps with external flushing water- or oil-lubricated bearings and seals, and enclosed line shafts.

3. Pumps for sewage, sludge, and other process fluids shall be grease lubricated or as indicated.

C. Hand holes

1. Provide hand holes on pump casings shaped to follow the contours of the casing in order to avoid any obstructions in the water passage.

D. Drains

1. Provide and connect pipe gland seals, air valves, and cooling water drains to the nearest floor sink or drain, using galvanized steel pipe or copper tube that is properly supported with brackets.

E. Stuffing Boxes

1. Where stuffing boxes are indicated for the pump seal, provide stuffing boxes of the best quality, using the manufacturer's suggested materials best suited for the specific application.

2. For sewage, sludge, drainage, and liquids containing sediments, provide fresh-water-flushed seals, using lantern rings.

3. If fresh water is not available, the seal shall be flushed with product water cleaned by a solids separator as manufactured by John Crane Co., Lakos (Claude Laval Corp.), or equal.

4. Conventional Packing Gland Type Seal

a. Unless otherwise indicated, provide packing material of Teflon braiding, containing 50 percent ultrafine graphite impregnation in order to satisfy the requirements listed in the table below.

b. Acceptable ring materials are asbestos-free die-molded packing rings of braided graphite material free of PTFE, Chesterton 1400R or equal, for non-potable water service, and braided PTFE material, Chesterton 1725 or equal, that is listed under NSF Standard 61 for potable water service.

F. Seal Requirements:

MecShaft speeds	up to 2500 fpm
Temperature	up to 500 deg F
pH range	- 14

1. Mechanical Seals

a. Provide mechanical seals of the fresh water-flushed-type, unless otherwise indicated in which case use product water cleaned by a solids separator as indicated above.

b. Provide conventional, non-split-type mechanical seals as manufactured by the following, or equal:

Chemicals or Corrosive Liquid Pumps	Single seals	John Crane Type 8-1 or 9, Flowserve Type ISCPX, or Chesterton Type UV, GSS, or 155
Water Pumps (hot and cold)	Single seals	John Crane Type 5610Q, Flowserve Type ISCPX, Chesterton Type UV, GSS, or 155

c. Where indicated, circulate a buffer fluid at a minimum 20 psi above discharge pressure, or as required by the manufacturer, in order to maintain reliable seal performance.

d. Equip mechanical seals with non-clogging, flexible–mounted seats with elastomer secondary seals.

e. Provide wetted metal parts constructed of Type 316 stainless steel, Alloy 20, or Hastelloy B or C, whichever has the best corrosion resistance to the pumped fluid.

f. Where double seals are specified, provide double-balanced dual cartridge seals in order to allow for seal integrity in case of flush water pressure reversal.

g. Provide springs in single and double seals, in the non-wetted end of the seal.

h. Deliver fresh water to the seals through appropriate size piping with plug valves, strainers, pressure regulators, electrically operated solenoid valves, and rotameters.

i. Wiring shall comply with the requirements of Division 26 – Electrical, and control shall comply with the requirements of Division 40 – Instrumentation and Control.

2.5 PUMP APPURTENANCES

A. Nameplates

1. Equip each pump with a stainless-steel nameplate indicating serial number(s), rated head and flow, impeller size, pump speed, and manufacturer's name and model number.

B. Gauges

1. Except for sample pumps, sump pumps, and hot water circulating pumps, equip pumps with pressure gauges installed at the pump discharge lines.

2. Provide pump suction lines with compound gauges.

3. Located gauges in a representative location, where not subject to shock or vibrations, in order to achieve true and accurate readings.

4. Where subject to shock or vibrations, wall-mount the gauges or attach the gauges to galvanized channel floor stands and connect by means of flexible connectors.

5. Provide pressure and compound gauges in accordance with the requirements of Section 40 73 00 - Pressure, Strain, and Force Measurement.

2.6 OWNER-FURNISHED OR OWNER-SUPPLIED

A. New Products

1. Furnish, install, startup and commission new pump systems equipment in accordance with the Contract Document.

B. Existing Products

1. Where existing pump equipment are specified to be removed and replaced, the Contractor shall remove and deliver to a storage or disposal location designated by the Owner. Cost for removal and transportation shall be included by the Contractor in his Bid.

PART 3 -- EXECUTION

3.1 SOURCE TESTING

A. Factory Testing: Conduct the following tests on each indicated pump system:

1. Motors

a. Test electric motors in accordance with the requirements of Division 26 and Division 43.

b. Furnish test results to the pump manufacturer prior to the pump test.

2. Variable Frequency Drives

a. Test variable frequency drives in accordance with the requirements of Division 26 and Division 43.

b. Furnish test results to the pump manufacturer prior to the pump test.

3. Certified Factory Non-witnessed Test

    a. Perform factory non-witnessed tests on centrifugal pumps with drives up to and including 125 hp in accordance with the ANSI/HI 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Test.

    b. For pumps with drives smaller than 15 hp, sump pumps, and sample pumps, pumps shall meet hydraulic acceptance criteria Grade "2U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

        1) Hydrostatic test in accordance with ANSI/HI 14.6 Appendix B - Hydrostatic Pressure Testing.

        2) Performance test at guaranteed design point or duty point documenting head, flow, bhp, and efficiency results.

        3) Unless otherwise indicated, it is not required to test NPSHr in the factory. Instead, manufacturer shall submit the published NPSHr curve in accordance with the requirements of this specification section.

        4) Additional tests as indicated in the specific pump specification sections.

    c. For pumps with drives 15 hp and larger shall meet hydraulic acceptance criteria Grade "1U" unless otherwise indicated. Such tests shall, at a minimum, consist of the following:

        1) Performance Test:

            a) Conduct performance testing at maximum speed, obtain a minimum of 5 hydraulic test readings between shutoff head and 25 percent beyond the maximum indicated capacity, and record on data sheets as defined by the Hydraulic Institute Standard.

            b) For variable speed driven pumps, test each pump between maximum and minimum speed at intervals no greater than 100 RPM.

            c) Submit pump curves showing head, flow, bhp, NPSHr and efficiency results. The manufacturer’s certification shall be visible on each submitted curve;

        2) Mechanical testing shall be limited to observation during the hydraulic performance test for any abnormal bearing temperature and pump vibration. Any deficiencies shall be corrected by the manufacturer.

        3) NPSHr3

            a) Perform a net positive suction head required test (NPSHr3), if required by the specific pump Section.

            b) Acceptance criteria shall be in accordance with ANSI/HI 14.6

            c) If not required by the specific pump Section, submit the published manufacturer calculated NPSHr3 curve.

4) Additional tests as indicated in the specific pump specification sections.

d. Perform tests for all pumps using the completely assembled project pump, motor, and VFD system (if equipped with variable speed drive). Calibrated factory motor may be used in lieu of project motor subject to approval of the Engineer.

e. Where multiple pumps are required in the project, one project variable speed drive and motor of each size shall be used for testing for all pumps as completely assembled systems.

f. Testing of prototype models will not be accepted.

g. Submit certification signed by a senior official of the pump manufacturer that the required pump shaft horsepower did not exceed the rated motor horsepower of 1.0 service rating at any point on the curve.

h. No equipment shall be shipped until the test data have been approved by the Engineer.

4. Certified Factory Witnessed Tests

a. Perform factory witnessed tests on all centrifugal pumps with drives 150 hp and larger or pumps with rated capacity of 10,000 gpm or greater in accordance with the certified factory non-witnessed test procedure indicated above for 15 hp to 125 hp pumps the exception that the tests shall be witnessed by the Owner and Engineer.

b. Mechanical tests shall be conducted in accordance with ANSI/HI 14.6, Appendix E, Mechanical Test. Such tests shall, at a minimum, consist of the following;

1) Measure and record overall motor winding temperature

2) Measure and record motor and pump bearing temperatures.

3) Measure and record motor and pump vibration.

4) Acceptance criteria and mechanical test records shall be in accordance with ANSI/HI 14.6, Appendix E, Mechanical Test.

c. Perform hydrostatic test in accordance to ANSI/HI 14.6 Appendix B – Hydraulic Static Pressure Testing.

d. The Contractor shall provide the Owner and Engineer a minimum of 2 weeks notification prior to the test.

e. Excluding salaries, costs for the attendances of one representative for the Owner and one representative for the Engineer shall be borne by the Contractor and shall be included in the Contract Price, including travel and subsistence costs. The cost shall include repetitive visits, if required. If additional witnessed testing is required due to failure of the pumps to meet specified conditions, expenses of the Engineer and Owner shall be covered by the Contractor.

f. No equipment shall be shipped until the test data have been approved by the Engineer.

5. Acceptance

a. In the event of failure of any pump to meet any of the requirements, make necessary modifications, repairs, or replacements in order to conform to the requirements of the Contract Documents, and re-test the pump until found satisfactory.

3.2 SOURCE QUALITY CONTROL

A. Quality Assurance

1. Pump Manufacturer Qualification.

a. Manufacturer shall have at least 10-years' experience designing and manufacturing similar to the type and size used in the project.

b. Manufacturer shall provide list of service centers nearest to the project.

2. ISO 9000 Certification and Quality Control Plan

3. Inspection Test Plan (ITP)

3.3 PROTECTION DURING SHIPMENT AND STORAGE

A. General: Unless otherwise specified in the specific Section for the equipment, this paragraph applies.

1. Shipping:

a. Equipment: Ship in sealed, weather-tight enclosed containers with silica gel desiccants to protect equipment from moisture and corrosion during shipment. Equipment shall be properly and protected against from being damaged or stresses during transport to the job site.

b. Bearing housings: Protect antifriction bearings from being damaged in transit due to moisture and contaminants. Shafts locked to equipment housing to prevent bearing damage during shipment.

2. Damage: Correct to conform to the Contract requirements before the assembly is incorporated into the work.

3. Factory applied coatings: Each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied prime coating.

4. Special monitoring: For the equipment listed below, a recording accelerometer, designed to record the magnitude of sudden impacts in 3 directions (X, Y, Z) on continuous strip charts with both time and "g" force scales, shall be shipped with, and fixed to each separately packed assembly or its packing crate. The units shall be shipped with a backup accelerometer and with new batteries. Upon arrival of each shipment, immediately notify the Project Representative; the accelerometer: shall be removed in the presence of representatives of the Project Representative and the Contractor. If the magnitude of the maximum acceleration exceeds 3.0 g, the assembly and any subassembly shall be dismantled and inspected for damage.

5. The following equipment shall be monitored during shipment:

    a. All electric motors and pumps 500 horsepower and larger.

    b. All variable speed drive units of all sizes.

3.4 WARRANTY

A. In addition to the warranty requirements specified in the General Conditions, the Contractor shall cause the pump manufacturer to warrant the units against defects in materials and workmanship for a period of 5 years or 10,000 hours under the specified uses and with normal operation and service. This warranty shall be delivered, in writing, to the Owner and shall include, as a minimum, 100 percent full payment coverage for parts and labor during the first 60 months or 10,000 hours of operation, whichever occurs first.

3.5 SERVICES OF MANUFACTURERS

A. Comply with Section 01 79 00 – Owner Staff Training.

B. Inspection, Startup, and Field Adjustment

1. Where required by the specific pump Section, furnish an authorized service representative of the manufacturer at the Site continuously to supervise the following items and to certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation:

    a. Installation of the equipment.

    b. Inspection, checking, and adjusting the equipment.

    c. Startup and field testing for proper operation; and

    d. Performance of field adjustments to ensure that the equipment installation and operation comply with the indicated requirements.

    e. Inspection, Startup, and Field Adjustment

C. Instruction of Owner’s Personnel:

a. Where required by the individual pump Section, furnish an authorized training representative of the manufacturer at the Site for the number of Days indicated in the specific pump Section, to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment.

b. Furnish instruction specific to the model of equipment provided.

D. Qualifications

1. Furnish a representative with at least 2 years' experience in training.

E. Resume: Submit a resume for the representative.

F. Schedule: Schedule the training a minimum of 3 weeks in advance of the first session.

G. Lesson Plan: Lesson Plan Review

1. Submit the proposed training material and a detailed outline of each lesson for review.

2. Incorporate review comments into the material.

3. The trainees will keep the training materials.

4. The Owner may videotape the training for later use with the Owner's personnel.

3.6 INSTALLATION

A. General

1. Install pumping equipment in accordance with the manufacturer's written recommendations.

B. Alignment

1. All pump bases shall be grouted in place after initial fitting and alignment of suction and discharge piping, but before final bolting of the connecting piping. The suction and discharge flange piping shall be laser aligned to the centerline of the pump nozzles and mating flanges square and parallel with each other. No pipe strain shall be transferred to the pump nozzle. After alignment and bolting, connections to the pump flange shall be checked using dial indicators for applied strain by loosening the flange bolts. If any of the flanges or joints move away (axially or laterally) from the true centerline of the pipe is observed, the piping shall be adjusted for proper fit.

2. Check equipment alignment after the grout had cured, all bolts torque checked and coupling adjusted to verify proper alignment and freedom from binding, scraping, shaft run out, or other defects.

3. Rotate the equipment manually and measure if shaft runout is within acceptable tolerance in order to ensure correct alignment without forcing.

4. Ensure that the equipment is secure in position and neat in appearance.

C. Submit certificate of affirmation that the equipment has been installed and aligned in accordance with the manufacturer's instruction. Installation and alignment check certificate shall be signed by the Contractor, Manufacturer and witnessed by the Engineer.

3.7 STARTUP AND COMMISSIONING

A. Comply with Section 01 75 00 – Equipment Testing and Plant Startup.

B. Additional Requirements

1. Provide the necessary oil and/or grease for initial operation.

3.8 FIELD TESTS

A. Field-test each pump system after installation simulating all of the operational scenarios as specified in order to demonstrate:

1. Satisfactory operation without excessive noise and vibration.

2. No material loss caused by cavitation.

3. No overheating of bearings; and,

4. Meet indicated head, flow, and efficiency at the design point.

B. Conduct the following functional field testing:

1. Startup, check, and operate the pump system over its entire speed range.

2. If the pump is driven by a variable speed drive, test the pump and motor at 100-RPM increments.

3. If the pump is driven by constant speed, test the pump and motor at the maximum RPM.

4. Unless otherwise indicated, vibration shall be within the amplitude limits recommended by the Hydraulic Institute standards at a minimum of 4 pumping conditions defined by the Engineer.

5. Field performance test: Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed, at 100-RPM increments if equipped with a variable speed drive or at maximum RPM if equipped with a constant speed drive.

6. Check each power lead to the motor for proper current balance.

7. Bearing Temperatures

a. Measure bearing temperatures by a contact-type thermometer.

b. Precede this test with a run time sufficient to stabilize bearing temperatures unless an insufficient liquid volume is available to furnish such a run time.

8. Ensure that electrical and instrumentation tests conform to the requirements of the Section under which that equipment is specified.

C. Witnessing

1. Field testing will be witnessed by the Engineer and the Owner representative.

2. Furnish 3 Days advance notice of field testing.

D. If the pumping system fails to meet the indicated requirements, modify or replace the pump and re-test as indicated above until it satisfies the indicated requirements.

E. Certification

1. After each pumping system has satisfied the requirements, certify in writing that it has been satisfactorily tested and that final adjustments have been performed.

2. Certification shall include the date of the field tests, a listing of persons present during the tests, and the test data.

F. The Contractor shall be responsible for costs of field tests, including related services of the manufacturer's representative, except for power and water, which the Owner will bear.

G. If available, the Owner’s operating personnel will provide assistance in field testing.

3.9 CLOSEOUT ACTIVITIES

A. Comply with Section 01 77 00 – Project Closeout.

3.10 PROTECTION

A. After completion of equipment installation and commissioning, but prior to acceptance by the owner, the surrounding areas shall be protected from being damaged.

3.11 MAINTENANCE

A. Provide for maintenance services applicable to critical systems such as pumping system, piping system, instrumentation and control and electrical systems as required. if not included in the construction contract, Maintenance service contract separate from the construction agreement can be negotiated to avoid delaying the final payment and holding the contract open for extended periods.

END OF SECTION

SECTION 43 23 13.45 – SELF-PRIMING SAMPLE PUMPS

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide and install self-priming sample pumps and appurtenant Work, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 21 00 - Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump which will satisfy the indicated requirements.

1.2 SUBMITTALS

A. In addition to the requirements of Section 43 21 00 – Pumps, General, the following shall be submitted in conformance with Section 01 33 00 - Submittal Procedures:

B. Technical brochures, bulletins, and data sheets for control and instrumentation components.

C. Control panel layout drawings, wiring, and schematic diagrams.

D. Submit vendor operation and manuals as specified in Section 01 73 00 – Installation, Operation, and Maintenance Manuals.

1.3 QUALITY ASSURANCE

A. Performance Curves: In no case shall the required horsepower at any point on the performance curve exceed the rated horsepower of the motor. If the estimated minimum horsepower specified is not adequate to satisfy the foregoing restriction or any other requirements of these specifications, the motor with the next larger horsepower shall be supplied at no additional cost to the Owner. In addition, any changes caused by the increase in motor horsepower or an approved decrease in specified motor power factor shall be made by the Contractor at no additional cost to the Owner; such changes may involve circuit breakers, magnetic starters, motor feeder conductors and conduit sizes, etc.

B. Equipment Testing: The Contractor shall be responsible for the coordination of the tests of the pump and motor as specified in Section 01 75 00 - Equipment Testing and Plant Startup.

C. Field Tests: The Contractor shall conduct field tests on all sample pumps as specified in Section 01 75 00 - Equipment Testing and Plant Startup.

1.4 SPARE PARTS

A. The Supplier shall furnish one spare pump of each model pump provided. Additionally, Supplier shall furnish, in accordance with 01 73 00 – Installation, Operation, and Maintenance Manuals , a list of recommended spare parts required for normal operation and maintenance of the equipment. The Owner will review this list with the Supplier and determine which spare parts are desired. Any spare parts requested will be purchased under a separate contract or purchase order at the discretion of the Owner.

PART 2 -- PRODUCTS

2.1 SAMPLE PUMPS

A. Sample pumps shall be selected and designed for continuous duty operation.

2.2 PERFORMANCE REQUIREMENTS:

A. Design Flow (gpm): 5.

B. Design Total Dynamic Head (TDH, ft): 100.

C. Maximum Motor Speed (rpm): 3,500.

D. Minimum Motor Size (hp): 0.3.

E. Motor Voltage (volts): 115.

2.3 PUMP DIMENSIONS:

A. Pump discharge size (inches): 1″ NPT.

2.4 PUMP REQUIREMENTS

A. Construction**:** Construction of sample pumps shall conform to the following requirements:

B. Pump housing (cap): 304 stainless steel.

C. Classification: IP44 – Waterproof (suitable for outdoor service)

D. Impeller: Noryl.

E. O-Rings and Gaskets: NBR.

F. Seal Plate: 316 stainless steel.

G. Seal: Mechanical seal.

H. Motor: Suitable for 120-volt, 1-phase, 60-Hz ac power supply.

I. Control: Pumps shall be controlled by a local disconnect switch.

1. Pumps to include a pressure switch to control pump operation. High pressure will turn the pump off and low pressure will turn the pump on.

2.5 MANUFACTURERS

A. Sample Pumps: Grundfos, Jet Pump, Model JP PS 13 03 137, or equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General: Pumping equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment: All equipment shall be field tested to verify proper alignment, operation as specified, and freedom from binding, scraping, vibration, shaft runout, or other defects. Pump drive shafts shall be measured just prior to assembly to ensure correct alignment without forcing. Equipment shall be secure in position and neat in appearance.

C. Lubricants: The Contractor shall provide the necessary oil and grease for initial operation.

3.2 PROTECTIVE COATING

A. Materials and equipment shall be coated as required in Section 09 96 00.10 – High Performance Coatings.

3.3 FIELD TESTS

A. Each pump shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, cavitation, or overheating of bearings.

B. The following field testing shall be conducted:

1. Startup, check, and operate the pump system over its entire speed range. Vibration shall be within the amplitude limits recommended by the Hydraulic Institute Standards at a minimum of 4 pumping conditions defined by the Contractor’s Engineer.

2. Obtain concurrent readings of motor voltage, amperage, pump suction head, and pump discharge head for at least 4 pumping conditions at each pump rotational speed. Check each power lead to the motor for proper current balance.

3. Determine bearing temperatures by contact type thermometer. A run time of at least 20 minutes shall precede this test.

4. Electrical and instrumentation tests shall conform to the requirements of the specification sections under which that equipment is specified.

C. Field-testing will be witnessed by the Owner's Representative. The Contractor shall furnish 3 days advance notice of field-testing.

D. In the event any pump fails to meet the test requirements, it shall be modified and retested as above until it satisfies the requirements.

E. After each pump has satisfied the requirements, the Contractor shall certify in writing that it has been satisfactorily tested and that all final adjustments have been made. Certification shall include the date of the field tests, a listing of all persons present during the tests, and the test data.

F. The Contractor shall bear all costs of field tests, including related services of the manufacturer's representative. If available, the Owner's operating personnel will provide assistance in field-testing.

3.4 MANUFACTURER'S FIELD SERVICE

A. Require manufacturer to inspect system before initial start-up and certify that system has been correctly installed and prepared for start-up as specified in this Section and in Sections 01 75 00 - Equipment Testing and Plant Startup and Section 43 21 00 – Pumps, General.

B. Training: As specified in Section 01 79 00 – Owner Staff Training.

END OF SECTION

SECTION 43 25 02 – STRAINERS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide pipe strainers, complete and operable, in accordance with the Contract Documents.

B. Strainers shall be of ample size, with the perforations suitable for each individual service, and designed for easy cleaning and removal of the strainer basket.

1.2 CONTRACTOR SUBMITTALS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures, for submittal requirements pertaining to BABA compliance.

B. General: Submittals shall be in accordance with Section 01 33 00 – Submittal Procedures.

C. Shop Drawings: Shop Drawings shall include construction details, sizes, dimensions, materials, and pressure ratings, in accordance with Section 46 10 00 – Equipment General Provisions.

PART 2 -- PRODUCTS

2.1 STRAINERS (PLASTIC BODY)

A. Equipment Requirements: Strainers shall be of the Y-pattern type with removable screen, magnetic drain plug, cap, and EPDM or Viton O-ring seal, and PVC body with solvent welded (less than 2-inch nominal diameters) and flanged (2-inch nominal diameter or larger) ends, rated for the following pressures at 73 degrees F:

1/2- to 2-inches	150 psi
1/2- to 2-inches	90 psi
3- to 4-inches	60 psi

B. Screen: The screens shall be of PVC, with a free area of 6 times the cross-sectional area of the pipe and 1/16-inch perforations.

C. Manufacturers, or Equal

1. **ASAHI/AMERICA**

2. **Hayward Industrial Products, Inc.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Unless otherwise indicated, strainers shall be provided ahead of any control valves, regulators, steam and condensate traps, and where indicated, and shall be preceded by shut-off valves.

B. Strainers shall be installed in accordance with the manufacturer's written instruction, in easily accessible locations for cleaning.

END OF SECTION

SECTION 43 25 05 - SUBMERSIBLE SUMP PUMPS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide submersible sump pumps and appurtenant WORK, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 21 00 - Pumps, General apply to this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARD

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 SUBMITTALS

A. Provide submittals per Section 01 33 00 – Submittal Procedures.

B. Submit the following:

1. Pump selection
2. Shop Drawings
3. Pump curves
4. Pump control panel
5. Pump Warranty

1.4 SAME MANUFACTURER

A. Where fluid service allows, provide pumps from a single manufacturer.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification: See Equipment Datasheets and the listed pumps below.

1. Decant Pumps

a. Pump Tag: 43-P-0110, 43-P-0120

1) Fluid Service: Clarified waster

2) Duty: 1 + 1

3) Drive: Constant

4) pH fluid range: 6-8

5) Maximum pump flowrate: 200 gpm

6) Maximum pump TDH: 20 ft

7) Electrical Requirements:

a) Maximum horsepower: 3

b) Voltage: 480 VAC

c) Phase: 3

2.2 PUMP REQUIREMENTS

A. Construction: Construction of submersible sump pumps shall conform to the following requirements:

Pump casing	Cast iron
Impeller	Semi-open, non-clog cast iron OR stainless steel (304 or 316)
Bearings	Permanently lubricated ball and sleeve type
Shaft	Stainless steel, series 400
Seal	Mechanical seal
Mounting Method	Anchored guide rail and flange adapter.
Pump Connection	Flanged, with guide rail adapter connection

B. Drive: Electric motors shall be furnished as indicated on each individual Equipment Datasheet.

C. Coating: Pumps shall be coated in accordance with Section 09 96 00.10 – High Performance Coatings.

2.3 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Section 40 90 10 - Control Strategies.

B. Float Control:

1. Provide integral pump floats on each pump to automatically stop pump operation when the float reaches its lowest setting and allow pump to run again when the float rises.

C. Vendor Control Panels (VCPs):

1. Provide vendor-supplied control panels per Section 26 05 15 – Industrial Control Panels and per the requirements of this Section.

2. Pump Description (Pump Tags):

a. Each pump shall be supplied with a vendor-supplied control panel (VCP) and shall house all required controls, circuit breakers, motor starters, and contacts. The VCP shall have a HAND/OFF/AUTO hand switch to permit local operation of each pump, and indicator lights for RUN status and FAIL status.

b. The VCP shall have dry contacts to provide remote monitoring via Owner's PLC/SCADA of all status signals as shown on the Contract Documents, which shall include at a minimum RUN status and FAIL status.

D. Contractor to provide cables from pumps to the control panels. Cables shall be UL listed and of length required in the Drawings to provide power from the control panels to the pumps. Cables shall be rated for use in submerged and chemical conditions as indicated.

E. Guide Rails

1. Provide guide rail system to allow for removal and replacement of sump pumps. Guide rails to be 304 or 316 SS, up to 1 1/2" diameter. Guide rail system to be anchored to bottom of sump with adapter ability to disconnect pump and replace pump without the need for personnel to enter the sump. Adapter shall provide a flanged seal between the pump and the discharge piping.

F. Removal chain

1. Provide chain for removal of pump. Chain to connect to pump handle. Chain shall be 316SS, with sufficient length to reach out of the containment sump. Upper end of chain shall be connected to a secure, dry place outside of the sump when not in use.

2.4 SPARE PARTS

A. Furnish spare pumps as listed below. Spare pumps shall be identical to those in service.

2.5 MANUFACTURERS, OR EQUAL

A. **Pentair**

B. **Flygt Corporation**

C. **Goulds Pumps Inc.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. General installation requirements shall be in accordance with Section 43 21 00 – Pumps, General.

3.2 TESTING

A. Once installed, test each pump in accordance with manufacturer recommendations. During testing, visually confirm the sump is being drained at the flowrates listed in this section, plus or minus 5 gallons per minute.

END OF SECTION

SECTION 43 30 52 – MISCELLANEOUS VALVES

PART 1 -- GENERAL

1.01 THE SUMMARY

A. The Contractor shall provide miscellaneous valves and appurtenances, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 40 05 51 – Common Requirements for Process Valves, apply to this Section.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

26 00 00	Electrical Work, General
40 05 51	Common Requirements for Process Valves

C. Reference Standards

American Water Works Association (AWWA)	
AWWA C511	Reduced-Pressure Principle Backflow Prevention Assembly
National Electrical Manufacturers Association (NEMA)	
Underwriters Laboratories (UL)	

1.03 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 40 05 51 – Common Requirements for Process Valves.

PART 2 -- PRODUCTS

2.01 SOLENOID VALVES

A. Solenoid valves shall be of the size, type, and class indicated and shall be designed for not less than 150 psi water-working pressure. Valves for water, air, or gas service shall have brass or bronze body with screwed ends, stainless steel trim and spring, Teflon or other resilient seals with material best suited for the temperature and fluid handled. Unless otherwise indicated, for chemicals and corrosive fluids, solenoid valves with PVC, CPVC, polypropylene (PP), polyvinylidene fluoride (PVDF), or Teflon materials of construction, suitable for the specific application shall be provided. Enclosures shall be NEMA rated in accordance with the area designations of Section 26 00 00 - Electrical Work, General. Coil ratings shall be for continuous duty. For electrical characteristics see the electrical Drawings or Specifications.

B. Manufacturers, or Equal

1. For general duty

    a. Automatic Switch Co. (ASCO), Model RED HAT

    b. Skinner Valve (Parker Hannifin Corporation)

    c. Magnatrol Valve Corporation

    d. J. D. Gould Co.

2. Metallic valves for corrosive fluids

    a. Valcor Engineering Corporation

3. Plastic valves for corrosive fluids

    a. +GF+ Plastic Systems, Inc.

    b. Spears Mfg. Co.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Valves shall be installed in accordance with the manufacturer's printed recommendations, and with this Section.

B. Backflow preventers, as well as air and vacuum release valves, shall have piped outlets to the nearest acceptable drain, firmly-supported, and installed in such a way as to avoid splashing and wetting of floors and obstruction of traffic.

END OF SECTION

SECTION 43 30 56 - HYDRAULIC GATES, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide hydraulic gates with appurtenances, complete and operable, in accordance with the Contract Documents.

B. The provisions of this Section shall apply to flap gates, slide gates, stop gates, cast iron slide gates, and shear gates, except where otherwise indicated in the Contract Documents.

C. The requirements of Section 46 10 00 – Equipment General Provisions, apply to this Section.

D. The requirements of Section 40 05 57 – Valve and Gate Actuators apply to this Section.

E. Single Manufacturer

1. The Contractor shall assign to a single manufacturer responsibility for the furnishing and functional operation of the hydraulic gates, including operators and accessories.

2. The designated single manufacturer, however, need not manufacture more than one part of the units, but shall coordinate the design, assembly, testing, and installation of the units.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. AWWA C561 Stainless Steel Slide Gates

ASTM A 276	Stainless Steel Bars and Shapes
ASTM B 21	Naval Brass Rod, Bar, and Shapes
ASTM B 584	Copper Alloy Sand Castings for General Applications

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit Shop Drawings of hydraulic gates as indicated in their respective Section.

C. Technical Manuals

1. Submit complete technical manuals, including printed instructions for proper maintenance, lubrication, and complete parts list indicating the various parts by name, number, and exploded view where necessary.

2. A list of recommended spare parts for the Owner to store at the facility shall be included.

D. Certification

1. The Contractor shall obtain written certification from the designated single manufacturer, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these Contract Documents, and that the designated single manufacturer accepts the Contractor's assignment of responsibility for coordination of gate equipment, including operators, controls, and services required for proper installation and operation.

E. Field Procedures

1. Prior to installation of the gates, provide instructions for field procedures for installation, adjustments, inspection, and testing.

1.4 QUALITY ASSURANCE

A. Equipment Field Testing

1. The Contractor shall be responsible for the coordination of the tests of each hydraulic gate in the presence of the manufacturer's factory service representative.

2. Excessive leaks shall be corrected and the equipment retested until found to be satisfactory.

1.5 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Installation and Startup Assistance

1. Service and testing assistance by the manufacturer's engineering representative for each gate and valve shall be furnished by the Contractor during installation and startup.

B. Instruction of Owner's Personnel

1. The Contractor shall arrange for the services of a factory service representative to instruct the Owner's personnel in the operation and maintenance of the equipment.

1.6 SPECIAL WARRANTY REQUIREMENT

A. The Contractor shall furnish the manufacturer's written guarantee that the hydraulic gates comply with the indicated requirements.

B. The Contractor shall furnish the manufacturer's warranties as published in its literature.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Equipment provided under this Section shall be new, of current manufacture, and shall be the products of reputable manufacturers specializing in the manufacture of such products and which have had previous experience in such manufacture.

B. The Contractor shall, upon request, furnish the names of not less than 5 successful installations of the manufacturer's equipment of comparable nature to that offered under the Contract.

C. Combinations of manufactured equipment which are provided under these Specifications shall be entirely compatible, and the Contractor and the manufacturer shall be responsible for the compatible and successful operation of the various components of the units.

D. Indicated and necessary mountings and appurtenances shall be included.

2.2 MATERIALS

A. Materials employed in the manufacture and installation of the hydraulic gates and operators shall be suitable for the intended application. Material not specifically called for shall be high-grade, standard commercial quality, free from defects and imperfection that might affect the serviceability of the product for the purpose for which it is intended.

2.3 HARDWARE

A. Bolts and nuts shall comply with the requirements of Section 05 50 00 – Metal Fabrications.

2.4 PROTECTIVE COATING

A. Coat ferrous metal in accordance with the requirements of Section 09 96 00.10 – High Performance Coatings

2.5 TOOLS AND SPARE PARTS

A. Tools

1. Furnish special tools that are necessary for maintenance and repair of the gates.

2. Such tools shall be suitably stored in metal toolboxes and identified with the equipment number by means of stainless steel or solid plastic nametags attached to the box.

B. Spare Parts

1. Furnish the following spare parts in a box as described above for tools, for air- or hydraulic-actuated gates for each type and size of gate:

a. one set of directional valves, solenoid or pilot actuated

b. one set of cylinder actuator seals

c. one set of filters

d. one repair kit for the hydraulic pump, containing seals or packing, gaskets, and O-rings.

C. NSF Compliance

1. All portions of hydraulic gates in contact with potable water shall be in compliance with NSF/ANSI 61.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Slide and shear gates shall be installed in strict accordance with the manufacturer's printed recommendations and the indicated requirements.

B. Operators shall be located as to avoid interference with handrails and structural members.

C. Damage to surface coatings incurred during shipment or installation shall be repaired.

END OF SECTION

SECTION 43 40 04 - WELDED STEEL TANKS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. General: The Contractor shall design and provide welded steel tanks, complete and operable, in accordance with the Contract Documents.

B. The Manufacturer shall design the tank foundation, including pipe penetrations, ladders, manways, railing, access hatches, roof vents, and connections to the tank as shown on the drawings.

C. The Manufacurer shall coordinate with the Geomembrane Baffle supplier to locate baffle supports and anchore points. See Section 13 38 00 – Geomembrane Baffles

D. The Work under this Section shall be furnished by manufacturers having experience in the manufacture of similar products and having a record of successful installations.

E. All steel shall be smelted and produced in the United States of America and meet American Iron and Steel and BABAA requirements.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. AWWA D100 Welded Steel Tanks for Water Storage

API 620	Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks
API 650	Welded Steel Tanks for Oil Storage
ASME	Boiler and Pressure Vessel Code
ASTM A 36	Structural Steel
ASTM A 131	Structural Steel for Ships
NFPA 30	Flammable and Combustible Liquids Code
SSPC-SP 5	White Metal Blast Cleaning
SSPC-SP 6	Commercial Blast Cleaning

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings: Manufacturer's information for each tank and its accessories.

1. List and sizes of tank installations by the manufacturer during the previous 10 years.

2. Detail erection drawings showing complete layout and orientation of the tank, fittings, attachments, support arrangements, and anchorage details.

3. Shell and Ends: Wall thickness and materials of construction.

4. Supports and Anchorage: Connection details, details of support leg attachment to shell, and support base plate and anchor bolt details.

5. Welding Information: Information regarding location, type, and extent of welds with references to Welding Procedure Specifications (WPS) in accordance with the ASME Boiler and Pressure Vessel (BPV) Code requirements. Shop Drawings shall distinguish between shop and field welds and indicate by welding symbols or sketches the details of the types of welded joints and preparation of parent metal to make them.

6. Inspection report as required in the BPV.

7. Shop Drawings shall be included for appurtenant equipment and control components for identifying a complete surge control system.

8. Equipment panels and components are identified by tag numbers for reference and location purposes in the Contract Documents. The same tag numbers shall be used on the Shop Drawings and other submittals.

9. Weight, empty and filled with water.

10. Capacity, gallons.

C. Cerificates

1. Certification of Material: Manufacturer shall certify that material of the tank is in accordance with the requirements of ASME Code Section VIII.

2. Certification of Welding Procedures and the Welders and Welding Operators for Shop and Field Welding: The qualification records of the welding procedures, and the welders and welding operators utilized for construction of the tank shall be certified by the manufacturer or Contractor and shall be accessible to the inspectors and Owner’s Representative.

3. Certification letter indicating compliance with American Iron and Steel and BABAA requirements.

4. For all components in contact with potable water, documentation of certification with NSF 61.

D. Design Calculations: Complete design calculations for the tank, conforming to the following:

1. Requirements of codes and commercial standards above.

2. Meet requirements of this Spec.

3. Design Calculations shall be prepared, signed and stamped by a civil or structural engineer registered in the state where project is located.

4. Anchor bolt calculations prepared, stamped, and signed by a structural or civil professional engineer registered in the State where the project is located.

E. Final Test Report: At the conclusion of the combined hydrostatic and pneumatic tests, the Contractor shall submit a complete test report which includes summaries of methods of testing, level of water in the tank, and setting of test pressure.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Tanks shall be manufactured by a firm with a minimum of 10 years' experience and having been regularly engaged in the design, manufacture, and installation of vessels of similar type and under loading conditions typical of transient pressure and flow in municipal water and wastewater applications. Code stamp is required for the tanks. The manufacturer shall be certified to use the BPV Code stamp.

B. The Contractor shall provide quality control services as required by this Section. In the event of a conflict between this Section and the ASME Code, the provisions of this Section govern.

C. Inspections shall be carried out by authorized inspectors regularly employed by an ASME-accredited authorized agency.

D. Radiographic Examination of Weld Joints

1. Weld joints shall be radiographed in accordance with the requirements of ASME Code Section VIII.

2. Personnel performing and evaluating radiographic examinations shall be qualified appropriately.

3. Examination procedures, acceptance standards, repair requirements of radiographic welds, and competence of examiners shall be in accordance with the requirements of ASME Code Section VIII.

E. Certification

1. The manufacturer shall certify that the materials used in the construction of the tank meet the requirements of this Section.

F. Identification of Materials

1. Material for pressure components shall be laid out during fabrication so that when the tank is completed, the complete set of original markings required for the material is plainly visible.

2. Testing and Treatment of Materials: Materials used in constructing the tank shall be tested and treated in accordance with the requirements of the BPV Code, Section VIII.

G. Inspection and Testing of Welding

1. Vessel manufacturer shall make records of certified welding procedures, qualifications of welders, and welding operators available to the inspector during manufacture of vessels.

2. The inspector or Owner's Representative may require requalification of welders and welding operators when there is specific reason concerning the ability of a welder or welding operators to follow or meet the requirements of the welding procedure specifications.

3. Welded joints shall be tested in accordance with the requirements of ASME Code Section VIII.

H. Hydrostatic testing and disinfection shall be furnished in accordance with Section 01 74 10 -Testing and Disinfection of Concrete and Steel Water Structures. The Owner will furnish water for testing and disinfection at the Site, but the Contractor will be required to convey the the water to fill the reservoir. The Contractor shall continuously monitor the filling operation to control the rate and level to avoid overflow.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Materials: Materials that are not indicated to be coated shall be fabricated from materials as indicated. Where materials are not indicated, the Contractor shall provide corrosion-resistant materials suitable for long-term service.

Service	Item	Material
Water	Flange nuts, bolts	Galvanized steel
	Submerged, wetted, or internal items	Type 316 stainless steel

B. Nameplates and Code Stamps: Each tank shall bear a stainless steel nameplate which contains the design and fabrication information required by the reference standard. Each nameplate shall bear the applicable code symbol.

C. Fabricators: Tanks shall be fabricated by fabricators authorized to apply the applicable code symbols.

D. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the reference standards, and excessive reinforcement shall be ground down to within the requirements, and as required to install the lining systems. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be ground to produce a workmanlike appearance, with uniform contours and dimensions. External corners and edges shall be ground to a 1/16-inch radius. Internal corners and edges shall be ground to a 1/8-inch radius, or a greater radius if required by the lining system.

E. Flat bottom tanks shall have butt-welded bottoms, with a steel thickness of at least 3/8-inch.

F. Openings 4-inches and greater in nominal diameter shall be reinforced.

G. Tank shell joints shall have complete joint penetration and fusion and shall be welded from both sides. Before the second side is welded the joint shall be arc-gouged to sound metal.

H. For flat bottom tanks, the corner joint shall be tested after the inside fillet weld is complete by applying a weld-compatible penetrating oil to the outside of the joint and observing the inside fillet weld for indications of oil penetration.

I. Shell attachments for pipe supports, tank gauges, instruments, and other items shall be welded to the tank shell before application of the tank lining.

J. After fabrication but prior to application of linings, each tank shall be tested in accordance with the reference standards.

K. Unless otherwise indicated, the minimum thickness for steel plates used for shells, roofs, or heads shall be 1/4-inch.

L. Tank details shall be designed to eliminate unwelded joints that promote corrosion pockets and accumulate rainwater or chemicals, and attachments to the shell which result in excessive localized stresses due to welding supports or imposed loads.

M. Access openings shall be flanged, and, unless otherwise indicated, have a nominal diameter of at least 24-inches. The cover plate and flange shall each have a net thickness after machining of at least 1/2-inch.

N. Fittings shall be flanged.

O. Refer to Section 01 33 17 – Structural Design, Support, and Ahcorage for anchorage support

P. Anchor bolts shall have a nominal diameter of at least one-inch, unless otherwise indicated, and shall be anchored into concrete foundations using methods designed to transfer the full ultimate strength of the anchor bolt to the concrete foundation. Anchor bolts shall be attached to the tank by use of anchor bolt chairs or rings, as required, and such chairs or rings shall be designed to transfer the full ultimate strength of the bolt, or 150 percent of the calculated load, whichever is less, to the tank shell.

Q. Buried and Exposed Surfaces: Unless otherwise indicated, coat in conformance with Section 09 96 00.10 – High Performance Coatings.

R. Appurtenances: Appurtenances shall include instrument mounting flanges, manholes, drain valves, lifting lugs, and liquid level gauge, and instrumentation indicated.

S. Connections: Each tank shall be furnished with pipe connections. Liquid level connections, drain, and an overflow pipe as indicated on the Contract Drawings. Cover overflow and drain outlets with 4-mesh stainless steel screen. Overflow outlet shall be terminated 12- to 24-inches above ground.

T. Access:

1. Safety: The following tank access components shall meet the most recent OSHA and local codes

2. Acces Hatch: Each tank shall have a 3'-8"x3'-4" hatch opening adjacent to the ladder as indicated on the Drawings. Hatch openings shall be hinged and lockable. Removable fall protection grating shall be provided beneath each access hatch. Hatch opening shall be curbed upward extending at least least 4 inches above the tank roof. The hatch cover shall include a watertight gasket. The hatch cover lip shall extend for a distance of 2 inches down on the outside of the curb.

3. Ladders: A ladder shall bne install onto the tank as shown on the Drawings

4. Ladders provided shall meet the most up-to-date safety codes and have a fall protection system as described in 05 50 00 – Metal Fabrications

5. Ladder Climb Prevention: Ladders shall be equipped with the most current, code compliant security shield, gate or other device to prevent unwated access to the ladder and tank roof

6. Manufacturer to submitcertificate or letter of compliance ensuring ladder meets current safety standards and codes.

U. Landing and Walkways: The tank shall have a non-skid walkwat with safety cable and handrail located on the roof for access to the vent, hatch, and bulkhead for the level transmitters as shown in the Drawings.

1. Handrails and safety cable anchor shall be made of metal, conforming to the requirements of Section 05 50 00 – Metal Fabrications

V. Pressure Rating: Unless otherwise indicated, unfired pressure tanks shall be fabricated in accordance with the ASME code for unfired pressure vessels, for a pressure rating of at least 50 percent above the maximum expected operating pressure.

W. Freeboard: The overall height indicated on the drawings may not satisfy the freeboard required by the design. The contractor's engineer shall be calculated freeboard for each tank based on the above design criteria. All tank roof (plate, beams), shell components and their connections shall be designed for additional loading due to the restriction of the freeboard as required by the design.

X. Vent: Provide a roof-mounted, centrally-located vent of non-frost design, sized for a maximum flow rate of water entering or leaving the tank of 3000 gpm so that excessive pressure or vacuum shall not develop (1/2-inch water column ignoring impact of overflow). Vent shall be designed and constructed to prevent the entrance of rainwater, animals, and insects. Insect screen shall have backing of removable 4-mesh stainless steel screen enclosed within the vent structure. An insect screen of 24 mesh polyester monofilament shall be provided and designed to open should the screen become plugged by ice formation. Vent shall include an integral or separate pressure-vacuum relief mechanism that will operate if the screens become plugged or frosted. The vent shall be constructed with a hood to prevent entrance of rainwater that can be unbolted and used as a secondary roof access.

Y. Protective coating: In accordance with Section 09 96 00.10 – High Performance Coatings.

Z. Tank Schedule**:** Provide the following welded steel tanks:

I.D. No.	Location	Service	Size, Ft	Capacity, gal
TK-0110	Yard	Water	28 Dia, 40 H	160,000

AA. Manufacturers: Tanks shall be fabricated by reputable manufacturers, experienced in the design and fabrication of the specific tanks, familiar with applicable local regulations, codes, fire and safety orders, and having a record of successful installations.

PART 3 -- EXECUTION

3.1 GENERAL

A. Installation: The Contractor shall install welded steel tanks and appurtenances in accordance with the Shop Drawings, applicable codes, and the Contract Documents.

3.2 WELDING

A. In assembly and during welding, component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the reference standards, and excessive reinforcement shall be ground down to within the requirements and as required to install the lining systems. Upon completion of welding, weld splatter, flux, slag, and burrs shall be removed. Welds shall be repaired to produce a workmanlike appearance with uniform contours and dimensions. External corners and edges shall be ground to a 1/16-inch radius. Internal corners and edges shall be ground to a 1/8-inch radius.

END OF SECTION

SECTION 43 40 08 - POLYETHYLENE TANKS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide polyethylene tanks and accessories, complete and in place, in accordance with the Contract Documents.

B. Unit Responsibility: The Contractor shall assign responsibility for furnishing the tank system as indicated to the tank manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Commercial Standards

ASTM D 618	Standard Practice for Conditioning Plastics for Testing
ASTM D 638	Tensile Properties of Plastics
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 883	Standard Terminology Relating to Plastics
ASTM D 1505	Standard Test Methods for Density of Plastics by the Density-Gradient Technique
ASTM D 1525	Standard Test Method for Vicat Softening Temperature of Plastics
ASTM D 1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 1998	Polyethylene Upright Storage Tanks
ASTM D 2765	Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross-linked Ethylene Plastics
ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D 3892	Standard Practice for Packaging/Packing of Plastics
ASTM F 412	Standard Terminology Relating to Plastic Piping Systems
ANSI B 16.5	Pipe Flanges and Flanged Fittings
ARM	Low Temperature Impact Resistance (Falling Dart Test Procedure)

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawing information

1. Tank Material

a. Data sheet

b. Information showing compatibility with chemical to be stored under the concentration and temperature conditions expected

c. Gasket style and material

d. Bolting material

2. Dimensioned tank drawings

a. Location and orientation of openings, fittings, accessories, instrumentation, and anchors and supports

b. Details of inlet and outlet fittings, manways, flexible connectors, and vents

3. Tank pad requirements

4. Calculations stamped and signed by a registered engineer and certified by the tank manufacturer.

a. Wall thickness. Hoop stress shall be indicated.

b. Tank restraint system. Design for seismic and wind criteria in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

C. Proposed manufacturer warranty

D. Manufacturer's unloading procedure

E. Manufacturer's installation instructions

F. Manufacturer’s written certification signed by a senior company officer stating that the tank design, type, and material is compatible with the indicated chemical to be stored in the tank.

G. Manufacturer’s Qualifications: List of installations documenting manufacturer's qualifications. Include names and telephone numbers for tank installations available for the ENGINEER to visit.

H. Technical Manual: Include the following in Part 2 - Operational Procedures:

1. Manufacturer's recommendations for installation.

2. Installation and adjustment procedures to include foundation bolt and piping connections to the tank.

3. Repair procedures for typical situations, including small holes, pinholes, and minor cracks in the tank.

I. Factory Test Report

1. Tank nominal capacity and diameter, material, hoop stress design

2. Review audit for wall thickness

3. Fitting placement

4. Visual inspection

J. Certification: After inspecting the installed tank, a representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted to the ENGINEER.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications

1. The tank manufacturer shall have a record of at least 10 installations during the previous 5 years for the tank sizes and for the chemicals indicated in this Contract.

1.5 SPECIAL WARRANTY REQUIREMENT

A. The tank shall be warranted for 3 years to be free of defects in material and workmanship.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Tanks shall be rotationally-molded high density crosslinked (HDXLPE) or high density linear polyethylene (HDLPE) as indicated, one piece seamless construction, cylindrical in cross-section, vertical in axis; complete with piping inlets and outlets, drains, and overflows installed by manufacturer; and anchoring system. Tanks shall be in accordance with ASTM D 1998 unless otherwise indicated. Lined or laminated tanks will not be accepted. Tank outlets shall be either molded on the tank and be the same material or mechanically attached to a chemical compatible insert encapsulated into the tank wall. Dome and other fittings may be threaded onto the tank. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, capacity, and chemical to be stored.

B. Dimensions and tolerances shall be in accordance with ASTM D 1998. Measurements shall be taken with the tank empty, in the vertical position.

2.2 TANKS

A. Service: Chemical storage tanks shall be suitable for the following operating conditions:

Equipment number	TK-0310
Chemical stored	Brine Solution
Concentration, percent	3.5%
Unit weight, lb/gal	10.3
Specific gravity	1.22
pH	4 - 5
Viscosity, centipoise at 68 deg. F	--
Maximum chemical temperature, deg. F	45
Minimum chemical temperature, deg. F	48
Minimum ambient air temperature, deg. F	40 – 80

B. Materials shall be virgin polyethylene as compounded and certified by the manufacturer, be the type indicated in the tank schedule, and shall meet or exceed the following:

1. Mechanical Properties of HDLPE Tank Material

Parameter	**ASTM Test Method**	**Value**
Density of resin, gm/cc	D 1505	0.942 to 0.947
Tensile strength, psi (2-inches per min)	D 638	2700
Elongation at break, percent (2-inches per min)	D 638	350
ESCR (100 percent Igepal, Condition A, F50), hours	D 1693	400 to 1000
ESCR (10 percent Igepal, Condition A, F50), hours	D 1693	200 to 500
Vicat softening temperature, deg. F	D 1525	235
Flexural modulus, psi	D 790	97,000 to 103,000

2. Resin used in the tank shall be by **Exxon Mobil Chemicals,** or equal, and shall contain ultraviolet stabilizer as recommended by the manufacturer. Where black or white tanks are indicated, the resin shall be compounded black or white.

C. Construction

1. The minimum wall thickness of the cylindrical portion at any chemical depth shall be determined by ASTM D 1998 as modified by the following equation. Wall thickness shall be tapered, and no wall shall be less than 0.187 inch thick at the top.

   T = (0.433 x ASG x OD x H) / (2 x SD)
   Where: T = wall thickness at any depth, in.
   ASG = adjusted specific gravity of chemical (See Note A)
   H = depth of chemical in tank ft
   OD = outside diameter of tank, in.
   SD = hydrostatic design stress, 600 psi (See Note B)

   a. Note A: The specific gravity of the fluid shall be multiplied by a service factor of 1.5 to 2.2, depending on the characteristics of the material stored within the tank. The service factor shall allow a design margin for a possible temperature excursion above 100 degrees F.

   b. Note B: The hydrostatic design stress shall be derated for temperatures above 100 deg F in accordance with ASTM D 1998.

   c. The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support. Flat areas shall be provided for attachment of large fittings on the cylindrical portion.

2. The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be in accordance with ASTM D 1998.

3. Tanks with 2000 gal capacity or larger shall have at least 3 lifting lugs molded into the top head. Lugs shall be designed for lifting an empty tank.

4. Tie-down lugs may be molded into the top head.

D. Tank Schedule

Equipment No.	TK-0310
Configuration (see Note 1)	FLR
Material Type	XLHDPE
Insulation	No
Nominal diameter, ft	3
Nominal height, ft (see Note 2)	4
Nominal capacity, gallons (see Note 5)	200
Liquid depth, maximum, ft	
Manway (see Notes 3 and 4) Mounting	N/A

Diameter, inches	
Exposure (UV protection required if tank is mounted outdoors)	Outdoors
Color	Natural

Note 1: CD = closed, domed top
CF = closed, flat top
OIF = open, internal flange
OEF = open, external flange
FLR = flat lid, removable
FLH = flat lid, hinged

Note 2: Nominal height of domed top tanks is the dimension measured along the straight cylindrical portion of the tank and does not include the rounded top.

Note 3: TM = top mount
TSM = top and side mount

Note 4: Unless otherwise indicated, manways shall be integrally molded with the tank.

Note 5: Nominal volume shall be calculated based on the straight cylindrical side of the tank.

E. Fittings

1. Tank fittings shall be according to the fitting schedule below. Gasket material shall be Buna-N, Viton. Fittings shall be compatible with the chemical stored, be bolted double flanged fittings, Schedule 80, or threaded bulkhead type. Threaded fittings shall use American Standard Pipe Threads. No metals shall be exposed to tank contents. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation.

Item	**Fitting Type (See Note 4)**
Equipment No.	TK-0310
Brine	IMF
Softened Water	IMF

Note 4: Refer to Drawings for fitting size and location. Abbreviations for fittings are:
TB: Threaded bulkhead fitting
BF-H: Bolted flange fitting with Hastelloy-C studs and polyethylene encapsulated heads.
BF-SS: Bolted flange fitting with 316 SS studs and polyethylene encapsulated heads.

BF-T Bolted flange fitting with titanium studs and polyethylene encapsulated heads
DB-SD: Double bolt with siphon drain, 316 SS studs, and polyethylene encapsulated heads.
IMF: Integrally molded flanged.
TST: Threaded siphon tube
SWST: Solvent-welded siphon tube
PVC: Double-nut PVC fitting.

a. Bulkhead fittings shall be constructed of PVC, PP, or other material compatible with the chemical stored. Gaskets shall be a minimum of 1/4-in thickness and be constructed of 40 to 50 durometer EPDM, 60 to 70 durometer Viton, or material compatible with the chemical in the tank.

2. Bolted flange fittings shall be constructed with two 150 psi flanges, two 150 psi flange gaskets, and the correct number and size of all-thread bolts recommended by the flange manufacturer. Flanges shall be constructed of PVC type 1, grade 1. Gaskets shall be min 1/4-in thick, constructed of 40 to 50 durometer EPDM, 60 to 70 durometer Viton, or material compatible with the chemical in the tank. There shall be minimum 4 full-thread bolts. Bolt heads may be gasket-flanged or may be encapsulated in a type of polyethylene compatible with the chemical stored. If encapsulated, the bolt head shall not contact the fluid in the tank and shall cover the head plus 1/4-in of threads away from the head. Polyethylene shall be color coded to identify the bolt metal underneath. Encapsulated heads shall have a gasket to provide a sealing surface against the inner flange. Bolt holes shall straddle the principal centerline of the tank in accordance with ASME B16.5

3. Integrally Molded Fittings (IMF). These fittings shall be an integral part of the tank and provide complete drainage of liquid through the sidewall of a flat bottom tank. The attachment shall be constructed from a Schedule 80 PVC, stainless steel, or compatible material and be standard at 2-, 3-, 4- or 6-in with inside diameter depending on the tank size.

4. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 5-ft max intervals with support from standard bulkhead fitting tank attachments or welded PE supports. Down pipes and fill pipes shall be PVC or material compatible with the chemical stored.

5. Flange Adapters: Adapters may be used to adapt threaded or socket fitting components to 150 psi flange connections. Adapters shall be of material compatible with the chemical stored.

6. Attachments: Pipe attachments at fittings shall be equipped with flexible couplers or other provisions for movement. Piping attachments shall allow for 3 to 4 percent movement.

2.3 LEVEL INDICATON

A. See Through Level Indication: Graduations shall be marked on the tank exterior at every 20 gallon intervals clearly labeled for bulk storage tanks.

B. Float Indication: The level indicator shall be completely assembled to the tank and shall consist of PVC float, indicator, polypropylene rope, perforated interior pipe, PVC roller guides, sunlight and chemical resistant sight tube, and necessary pipe supports. The level indicator shall act inversely to the tank contents and shall not allow entrance of tank contents into the sight tube at any time.

2.4 TANK STANDS, SEISMIC, AND WIND RESTRAINT SYSTEM

A. The restraint assembly shall be designed and manufactured for in accordance with 01 33 17 – Structural Design, Support and Anchorage. No liquid weight may be used to resist seismic uplifting and overturning where tanks are not anchored.

B. Wind restraint for outdoor tanks shall be designed to resist the indicated wind velocity with the tank empty.

2.5 SAFETY SIGNS

A. Each tank shall be clearly marked with hazardous material warning signs. Each sign shall have the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign reading "DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE". Signs shall comply with 1 10400 - Signage and the requirements herein.

2.6 FACTORY TESTING

A. Material Testing

1. Low temperature impact test: Condition samples taken from fitting cutouts frozen for 2 hours at minus 40 degrees F. Perform impact tests in accordance with ASTM D 1998. Specimens less than 1/2-in thick shall be tested at 100 ft.-lb. and specimens equal to or thicker than 1/2 -in shall be tested at 200 ft.-lb.

2. Degree of cross-linking (applicable to cross link material only): Use Method C of ASTM D 2765 to determine the ortho-xylene insoluble fraction of cross-linked polyethylene. Samples from the inside of the tank 1/8-in deep shall test at no less than 65 percent.

B. Tank Testing

1. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be 1/2-in vertical and 2 degrees radial.

2. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.

3. Wall Thickness

a. Tanks 2000 gal or larger shall be measured for wall thickness by ultrasonic methods at 6-in, 1-ft, 2-ft, and 3-ft up the sidewall at zero and 180 degrees around the circumference from the outlet.

b. Tanks smaller than 2000 gal may be tested during a production run and the results reported as representative of each tank in the run.

4. Hydrostatic test: Following fabrication, the tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the brim for a minimum of 4 hours and inspecting for leaks. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated requirements have been met.

2.7 MANUFACTURERS, OR EQUAL

A. **Poly Processing Company**

B. **Snyder Industries, Inc.**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation of tank and connections, the tank shall be water tested by filling the entire tank with water and monitoring the tank and connections for at least 24 hours. Leaks shall be corrected prior to acceptance. Following successful field testing, the tank shall be completely emptied and dried.

END OF SECTION

SECTION 43 40 09 – DOUBLE-WALLED POLYETHYLENE TANKS

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The Contractor shall provide double-walled polyethylene tanks and accessories, complete and in place, in accordance with the Contract Documents.

B. Unit Responsibility: The Contractor shall assign responsibility for furnishing the tank system as indicated to the tank manufacturer.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Commercial Standards

ASTM D 618	Standard Practice for Conditioning Plastics for Testing
ASTM D 638	Tensile Properties of Plastics
ASTM D 746	Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D 883	Standard Terminology Relating to Plastics
ASTM D 1505	Standard Test Methods for Density of Plastics by the Density-Gradient Technique
ASTM D 1525	Standard Test Method for Vicat Softening Temperature of Plastics
ASTM D 1693	Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 1998	Polyethylene Upright Storage Tanks
ASTM D 2765	Standard Test Methods for Determination of Gel Content and Swell Ratio of Cross-linked Ethylene Plastics
ASTM D 2837	Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
ASTM D 3892	Standard Practice for Packaging/Packing of Plastics
ASTM F 412	Standard Terminology Relating to Plastic Piping Systems
ANSI B 16.5	Pipe Flanges and Flanged Fittings

ARM Low Temperature Impact Resistance (Falling Dart Test Procedure)

AWWA Drinking Water System Components

NEMA ICS 6 Enclosures for Industrial Control and Systems

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 - Submittal Procedures.

B. Shop Drawing information

1. Tank Material

a. Data sheet

b. Information showing compatibility with chemical to be stored under the concentration and temperature conditions expected.

c. Fitting Material

d. Gasket style and material

e. Bolting material

2. Dimensioned tank drawings

a. Location and orientation of openings, fittings, accessories, instrumentation, restraints anchors and supports

b. Details of inlet and outlet fittings, manways, flexible connectors, and vents

3. Tank pad requirements.

4. Calculations stamped and signed by a registered engineer in the State of Washington and certified by the tank manufacturer.

a. Wall thickness. Hoop stress shall be indicated.

b. Tank restraint system. Design for seismic and wind criteria in accordance with Section 01 33 17 – Structural Design, Support and Anchorage.

C. Proposed manufacturer warranty

D. Manufacturer's unloading procedure

E. Manufacturer's installation instructions

F. Manufacturer’s written certification signed by a senior company officer stating that the tank design, type, and material is compatible with the indicated chemical to be stored in the tank.

1. Supporting documentation of Manufacturer’s certification to NSF/ANSI Standard 61 – Drinking Water System Components for water treatment chemicals.

G. Manufacturer’s Qualifications: List of installations documenting manufacturer's qualifications. Include names and telephone numbers for tank installations available for the Engineer to visit.

H. Technical Manual: Include the following in Part 2 - Operational Procedures:

1. Manufacturer's recommendations for installation.

2. Installation and adjustment procedures to include foundation bolt and piping connections to the tank.

3. Repair procedures for typical situations, including small holes, pinholes, and minor cracks in the tank.

I. Factory Test Report

1. Tank nominal capacity and diameter, material, hoop stress design

2. Review audit for wall thickness

3. Fitting placement

4. Visual inspection

5. Impact test

6. Gel test

7. Hydrostatic test

J. Certification: After inspecting the installed tank, a representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted to the Engineer.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications

1. The tank manufacturer shall have a record of at least 10 installations during the previous 5 years for the tank sizes and for the chemicals indicated in this Contract.

1.5 SPECIAL WARRANTY REQUIREMENT

A. The tank shall be warranted for 3 years to be free of defects in material and workmanship.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Tanks shall be rotationally-molded high density crosslinked (HDXLPE) or high density linear polyethylene (HDLPE) as indicated. The tank assembly shall consist of one cylindrical, closed-top inner tank and one cylindrical, open-top containment outer tank. Each tank shall be rotationally molded, one piece seamless construction, cylindrical in cross-section, vertical in axis; complete with piping connections installed by manufacturer; and anchoring system. Tanks shall be in accordance with ASTM D 1998 unless otherwise indicated. Lined or laminated tanks will not be accepted. Tank outlets shall be either molded on the tank and be the same material or mechanically attached to a chemical compatible insert encapsulated into the tank roof. Covered tanks shall be vented, and where indicated, tanks shall be provided with entrance manways, level indicators. The tank shall be provided with ancillary mechanical fittings and accessories, as indicated in the Drawings. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, capacity, and chemical to be stored.

B. Dimensions and tolerances shall be in accordance with ASTM D 1998. Measurements shall be taken with the tank empty, in the vertical position.

2.2 TANKS

A. Service: Chemical storage tanks shall be suitable for the following operating conditions:

Equipment number	TK-0501	TK-0350	TK-0201
Chemical stored	Sodium Hydroxide	Sodium Hypochlorite	Aluminum Chlorohydrate
Concentration, percent	25%	0.8%	50%
Unit weight, lb/gal	10.7	10.1	11.2
Specific gravity	1.278	1.2	1.34
pH	14	12 – 14	4 - 6
Viscosity, centipoise at 68 deg. F	6-9	1-3	20-25
Chemical temperature, deg. F	45 to 85	45 to 85	45 to 85
Ambient environment	Indoors	Indoors	Indoors
Ambient temperature, deg. F	50 to 80	50 to 80	50 to 80

B. Materials shall be high density cross-linked polyethylene as compounded and certified by the manufacturer, be the type indicated in the tank schedule, and shall meet or exceed the following:

C. Generally, tanks molded from high density linear polyethylene resin, HDLPE are more economical, are repairable by welding, can be disposed of by recycling, and can be obtained with FDA and NSF certification.

D. The recommended tank system materials are:

Chemical Stored	Concentration	Resin (See Note 1)	Fitting Material	Gasket Material	Bolt Material
Sodium Hypochlorite	0.8%	XLHDPE	PVC	viton	titanium
Aluminum Chlorohydrate	50% liquid ACH	XLHDPE	PVC	EPDM	316 SS
Sodium Hydroxide	25%	XLHDPE	PVC	neoprene or EPDM	316 SS

1. Mechanical Properties of HDXLPE Tank Material

Parameter	ASTM Test Method	Value
Density of resin, gm/cc	D 1505	0.938 to 0.944
Tensile strength, psi (2-inches per min)	D 638	2600
Elongation at break, percent (2-inches per min)	D 638	400
ESCR (100 percent Igepal, Condition A, F50), hours	D 1693	1000
ESCR (10 percent Igepal, Condition A, F50), hours	D 1693	greater than 1000
Vicat softening temperature, deg. F	D 1525	248
Flexural modulus, psi	D 790	100,000

2. Resin used in the tank shall be by **Exxon Mobil Chemicals,** or equal, and shall contain ultraviolet stabilizer as recommended by the manufacturer. Where black or white tanks are indicated, the resin shall be compounded black or white.

E. Construction

1. The minimum wall thickness of the cylindrical portion at any chemical depth shall be determined by ASTM D 1998 as modified by the following equation. Wall thickness shall be tapered, and no wall shall be less than 0.187 inch thick at the top.

T = (0.433 x ASG x OD x H) / (2 x SD)

Where: T = wall thickness at any depth, in.
ASG = adjusted specific gravity of chemical (See Note A)
H = depth of chemical in tank ft
OD = outside diameter of tank, in.
SD = hydrostatic design stress, 600 psi (See Note B)

a. Note A: The specific gravity of the fluid shall be multiplied by a service factor of 1.5 to 2.2, depending on the characteristics of the material stored within the tank. The service factor shall allow a design margin for a possible temperature excursion above 100 degrees F.

b. Note B: The hydrostatic design stress shall be derated for temperatures above 100 deg F in accordance with ASTM D 1998.

c. The minimum wall thickness shall be sufficient to support its own weight in an upright position without external support but shall not be less than 0.187" thick.

2. The top head shall be integrally molded with the cylindrical wall. Its minimum thickness shall equal the thickness of the top of the wall. The top head of tanks 2000 gal and larger shall provide a minimum of 1300 square inches of flat surface for pipe nozzle locations.

3. The bottom head shall be integrally molded with the cylindrical wall. Knuckle radius shall be 1 inch for tank diameter less than or equal to 6 feet and be 1.5 inch for greater than 6 feet.

4. Tanks with 3000 gal capacity or larger shall have at least 3 lifting lugs molded into the top head. Lugs shall be designed for lifting an empty tank.

5. Tie-down lugs may be molded into the top head.

6. Manway and Non-sealed Fill Cap

a. Unless otherwise indicated, fill caps shall be 10-inches diameter, vented-threaded style with a minimum opening diameter of 7-1/8 in. Cap attachment shall be provided with standard 10-in cap placements with a polyurethane cap tie.

b. Unless otherwise indicated, manways shall be at the top of each tank, and shall be 17-in slip fit style with a coarse thread

c. . Gaskets shall be closed cell, cross-linked polyethylene foam and Viton materials.

F. Tank Schedule

Equipment No.	TK-0501	TK-0350	TK-0201
Configuration (see Note 1)	CD	CD	CD

Equipment No.	TK-0501	TK-0350	TK-0201
Material Type	XLHDPE	XLHDPE	XLHDPE
Insulation	No	No	No
Nominal diameter, ft	4	5	4
Nominal height, ft (see Note 2)	5.1	6.1	5.1
Nominal capacity, gallons, each (see Note 5)	400	750	400
Manway (see Notes 3 and 4) Mounting Diameter, inches	 TM 17	 TM 22	 TM 17
Exposure (UV protection required if tank is mounted outdoors)	Indoors	Indoors	Indoors
Color	Natural	Natural	Natural

Note 1: CD = closed, domed top
CF = closed, flat top
OIF = open, internal flange
OEF = open, external flange
FLR = flat lid, removable
FLH = flat lid, hinged

Note 2: Nominal height of domed top tanks is the dimension measured along the straight cylindrical portion of the tank and does not include the rounded top.

Note 3: TM = top mount
TSM = top and side mount

Note 4: Unless otherwise indicated, manways shall be integrally molded with the tank.

Note 5: Nominal volume shall be calculated based on the straight cylindrical side of the tank.

G. Fittings

1. Tank fittings shall be according to the fitting schedule as shown on the drawings. Fittings shall be compatible with the chemical stored, be Bolted One-Piece Sure Seal (B.O.S.S.), double flange fittings constructed of virgin polyethylene. Threaded fittings

shall use American Standard Pipe Threads. No metals shall be exposed to tank contents.

Refer to Drawings for fitting size and location. Abbreviations for fittings are:

BF-H: Bolted flange fitting with Hastelloy-C studs and polyethylene encapsulated heads.

BF-SS: Bolted flange fitting with 316 SS studs and polyethylene encapsulated heads.

BF-T Bolted flange fitting with titanium studs and polyethylene encapsulated heads

DB-SD: Double bolt with siphon drain, 316 SS studs, and polyethylene encapsulated heads.

IMF: Integrally molded flanged.

TST: Threaded siphon tube

SWST: Solvent-welded siphon tube

PVC: Double-nut PVC fitting.

2. Bolted flange fittings shall be constructed of one 150 lb. flange with ANSI bolt pattern, one flange gasket and stud bolts with gaskets. Stud bolts to have chemical resistant polyethylene injection molded heads and gaskets to provide a sealing surface between the bolt head and the interior tank wall. Stud bolt heads are to be color coded for visual ease of identifying the bolt material by onsite operators. Green- 316 Stainless Steel, Black- Titanium, Red- Alloy C-276, Blue- Monel. All materials shall be compatible with chemical service and as indicated in the fitting schedule above. For NSF/ANSI 61 certification, EPDM or Viton GF gaskets shall be supplied.

3. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 6-ft max intervals. Down pipes and fill pipes shall be PVC or material compatible with the chemical stored.

4. U-Vents: Each tank must be vented for the material and flow and withdrawal rates expected. Vents should comply with OSHA 1910.106(F)(iii)(2)(IV)(9). U-vents shall be sized by the tank manufacturer and be furnished complete with insect screen if required (Insect screen lessens the vent capacity by 1/3) in accordance with the venting schedule listed above.

5. Flange Adapters: Adapters may be used to adapt threaded or socket fitting components to 150 psi flange connections. Adapters shall be of material compatible with the chemical stored. Flange shall have one full face gasket to provide a sealing surface against inside tank wall. For NSF-61 applications, EPDM or Viton gaskets shall be supplied.

6. For double-walled tanks greater than 1,000-gallons, bottom fittings shall be designed to maintain 110% secondary containment integrity. Secondary containment fittings shall be resistant to chemical corrosion. Fitting shall include the option to connect a secondary containment pipe over primary pipe.

7. All fittings on the 1/3 lower sidewall of tanks with capacities > 1000 gallons shall have 100% virgin PTFE expansion joint. Expansion joint to have 3 convolutions, stainless steel limit cables, FRP composite flanges and meet the following minimum performance specifications. Galvanized parts will not be accepted. Expansion joints to meet the following minimum performance requirements:

a. Axial Compression ≥ 0.67”

b. Axial Extension ≥ 0.67”

c. Lateral Deflection ≥ 0.51”

d. Angular Deflection ≥ 14º

e. Torsional Rotation ≥ 4º

8. Attachments: Pipe attachments at fittings shall be equipped with flexible couplers or other provisions for movement. Piping attachments shall allow for 3 to 4 percent movement.

2.3 LEVEL INDICATON

A. Ultrasonic Level Indicator: The ultrasonic level indicator shall consist of Flowline ultrasonic level transmitter, level controller4 - 20 mA or 0-10 VDC continuous level input and NEMA 4X box to be supplied by tank manufacturer.

B. Level transmitter shall be by radar level transmitter as indicated in Section 40 72 00 - Level Measurement.

2.4 TANK STANDS, SEISMIC, AND WIND RESTRAINT SYSTEM

A. The tank shall be provided on a stand or support as indicated and shall be bolted to the floor or concrete foundation system.

B. The restraint assembly shall be designed and manufactured for in accordance with Section 01 33 17 – Structural Design, Support and Anchorage. No liquid weight may be used to resist seismic uplifting and overturning where tanks are not anchored.

C. Tank restraint system shall be supplied and the design of same certified by a Structural Engineer registered in the State of tank installation. Design shall conform to the most recent edition of the IBC code for seismic and wind load. Anchor bolts as required by the calculations shall be supplied by the tank manufacturer.

2.5 SAFETY SIGNS

A. Each tank shall be clearly marked with hazardous material warning signs, 10-inches by 14-inches in size. Each sign shall have the word "DANGER" and the name of the chemical stored, printed in large block letters and mounted directly adjacent to the tank outlet and tank inlet. Each entry manway shall be provided with a sign reading "DANGER--CONFINED SPACE--HAZARDOUS ATMOSPHERE".

2.6 FACTORY TESTING

A. Material Testing

1. Low temperature impact test and Gel Test: Condition samples taken from fitting cutouts frozen for 2 hours at minus 40 degrees F. Perform impact tests in accordance with ASTM D 1998. Specimens less than 1/2-in thick shall be tested at 100 ft.-lb. and specimens equal to or thicker than 1/2 -in shall be tested at 200 ft.-lb.

2. Degree of cross-linking (applicable to cross link material only): Use Method C of ASTM D 2765 to determine the ortho-xylene insoluble fraction of cross-linked polyethylene. Samples from the inside of the tank 1/8-in deep shall test at no less than 65 percent.

B. Tank Testing

1. Dimensions: Take exterior dimensions with the tank empty, in the vertical position. Outside diameter tolerance, including out-of-roundness, shall be per ASTM D 1998. Fitting placement tolerance shall be 1/2-in vertical and 1 degrees radial.

2. Visual: Inspect for foreign inclusions, air bubbles, pimples, crazing, cracking, and delamination.

3. Wall Thickness

a. Tanks 2000 gal or larger shall be measured for wall thickness by ultrasonic methods at 6-in, 1-ft, 2-ft, and 3-ft up the sidewall at zero and 180 degrees around the circumference from the outlet.

b. Tanks smaller than 2000 gal may be tested during a production run and the results reported as representative of each tank in the run.

4. Hydrostatic test: Following fabrication, the tanks, including inlet and outlet fittings, shall be hydraulically tested with water by filling to the brim for a minimum of 1 hours and inspecting for leaks. Following successful testing, the tank shall be emptied and dried prior to shipment.

C. An affidavit signed by the tank manufacturer shall be furnished indicating that the factory tests have been performed and the indicated requirements have been met.

2.7 MANUFACTURERS, OR EQUAL

A. **Poly Processing Company**

B. **Snyder Industries, Inc.**

C. **Peabody**

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the manufacturer's recommendations.

3.2 FIELD TESTING

A. After installation of tank and connections, the tank shall be water tested by filling the entire tank with water and monitoring the tank and connections for at least 24 hours. Leaks shall be corrected prior to acceptance. Following successful field testing, the tank shall be completely emptied and dried.

END OF SECTION

SECTION 46 10 00 – EQUIPMENT GENERAL PROVISIONS

PART 1 -- GENERAL

1.1 SUMMARY

A. The provisions of this Section shall apply to all equipment throughout the Contract except where otherwise indicated.

B. The Contractor shall provide equipment and appurtenant Work, complete and operable, in accordance with the Contract Documents.

C. Equipment Arrangement: Unless specifically indicated otherwise, the arrangement of equipment indicated is based upon information available from manufacturers at the time of design and it is not intended to show exact dimensions particular to a specific manufacturer. Some aspects of the Drawings are diagrammatic, and some features of the illustrated equipment arrangement may require revision by the Contractor to meet the actual equipment requirements proposed by the Contractor. Structural supports, foundations, piping and valve connections, and electrical and instrumentation connections indicated may have to be altered by the Contractor to accommodate the equipment provided. No additional payment will be made to the Contractor for such revisions and alterations. Substantiating calculations and drawings shall be submitted prior to beginning the fabrication of equipment.

D. Unit Responsibility:

1. The Contractor shall furnish, coordinate, assemble, install, and test the system as an operating unit. Unless otherwise specified:

2. The Contractor shall furnish, coordinate equipment selection with the manufacturer of the driven equipment to insure compatibility. The manufacturer shall assure selected components of the system are checked for compatibility, ease of construction, and efficient operation and maintenance. The manufacturer shall ensure coordination of design of all system components such that all equipment furnished under the specifications for the equipment system, including equipment specified elsewhere but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Agents, representatives, or other entities who are not a direct component of the manufacturing corporation will not be acceptable as a substitute for the manufacturer's corporation in meeting this requirement.

3. This requirement for unit responsibility shall in no way relieve the Contractor of responsibility for meeting the overall performance of equipment as specified in the Contract Provisions.

4. The Contractor shall assure that all equipment systems provided for the project are products for which unit responsibility has been coordinated by the responsible party.

5. Where the specification requires a Certificate of Unit Responsibility, submit a statement signed by an officer of the manufacturer's corporation, and certified by the Contractor that the equipment have been designed, selected and coordinated are compatible with the overall integrated system as specified.

6. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory.

E. Single Manufacturer: Where two or more pieces of equipment of the same type or same size are required, the equipment shall be produced by the same Manufacturer unless specifically indicated otherwise.

F. Where Vendor Control Panels (VCP's) are specified, the VCP's shall be provided in accordance with the requirements of Section 40 61 05 – Package System.

G. Protection During Shipment and Storage

1. General: Unless otherwise specified in the specific Section for the equipment, this paragraph applies.

2. Shipping:

a. Equipment: Ship in sealed, weather-tight enclosed containers with silica gel desiccants to protect equipment from moisture and corrosion during shipment. Equipment shall be properly and protected against from being damaged or stresses during transport to the job site.

b. Bearing housings: Protect antifriction bearings from being damaged in transit due to moisture and contaminants. Shafts locked to equipment housing to prevent bearing damage during shipment.

3. Damage: Correct to conform to the Contract requirements before the assembly is incorporated into the work.

4. Factory applied coatings: Each item of equipment shall be shipped to the site of the work with the manufacturer's shop applied prime coating.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Abbreviations and Acronyms

1. Refer to DRAWINGS for site-specific acronyms.

C. Reference Specifications

01 10 00	Summary of Work
01 33 00	Submittal Procedures
01 33 17	Structural Design, Support and Anchorage
01 73 00	Installation, Operation, and Maintenance Manuals
01 73 10	Training of Operations and Maintenance Personnel
01 75 00	Equipment Testing and Plant Startup

01 79 00	Owner Staff Training
03 60 00	Grouting
05 50 00	Metal Fabrications
09 96 00.10	High-Performance Coatings
40 05 01	Piping, General
40 05 07	Pipe Supports
43 21 00	Pumps, General

D. Reference Standards

American Bearing Manufacturers Association (ABMA)	
American Gear Manufacturers Association (AGMA)	
American National Standards Institute (ANSI)	
ANSI B46.1	Surface Texture (Surface Roughness, Waviness, and Lay)
ANSI S12.6	Method for the Measurement of the Real-Ear Attenuation of Hearing Protectors
American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)	
American Society of Mechanical Engineers (ASME)	
ASME B16.1	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
ASME B16.5	Pipe Flanges and Flanged Fittings, Steel, Nickel Alloy, and other Special Alloys
ASME B46.1	Surface Texture
ASME B1.20.1	General Purpose Pipe Threads (Inch)
ASME B31.1	Power Piping
ASME B31.3	Process Piping
American Water Works Association (AWWA)	
AWWA M11	Steel Pipe – A Guide for Design and Installation
AWWA C206	Field Welding of Steel Water Piping
AWWA C207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm through 3,600 mm)
AWWA D100	Welded Steel Tanks for Water Storage
American Welding Society (AWS)	
American Society for Testing and Materials (ASTM)	
ASTM A 48	Gray Iron Castings
ASTM A 108	Steel Bars, Carbon, Cold-Finished, Standard Quality
Federal Specifications (FS)	
General Industry Safety Orders (GISO)	
Hydraulic Institute (HI)	

Mechanical Power Transmission Association (MPTA)	
National Electrical Manufacturers Association (NEMA)	
National Fire Protection Association (NFPA)	
NFPA 820 Standard for Protection in Wastewater Treatment and Collection Facilities	
NSF International (NSF)	
NSF/ANSI 61	Drinking Water System Components – Health Effects
Occupational Safety and Health Administration (OSHA)	
Underwriters Laboratories (UL)	
Rubber Manufacturers Association (RMA)	

1.3 CONTRACTOR SUBMITTALS

A. Product Data

1. Submit product data consisting of manufacturer's printed data sheet or catalog cuts illustrating product information required to demonstrate that the equipment meets project section subject to review by the Engineer.

B. Shop Drawings Submittals

1. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

2. Shop Drawings: Furnish complete drawings and technical information for equipment, piping, valves, and controls. Where indicated or required by the Engineer, Shop Drawings shall include clear, concise calculations showing equipment anchorage forces and the capacities of the anchorage elements proposed by the Contractor.

3. Spare Parts List: The Contractor shall obtain from the manufacturer and submit as part of Shop Drawings a list of specified and recommended spare parts for each piece of equipment. Contractor shall also furnish the name, address, and telephone number of the nearest distributor for each piece of equipment.

4. For materials in contact with potable water or process water that will be deemed potable after treatment processes, provide certification for by an independent ANSI accredited third party.

   a. In accordance with NSF 61.

   b. Weighted average lead content of less than 0.25 percent in accordance with NSF 372.

1.4 QUALITY ASSURANCE

A. Costs: Responsibility shall be by the Contractor's for performing and paying the costs of inspection, startup, testing, adjustment, and instruction services performed by factory representatives. The Owner will pay for costs of power and water. If available, the Owner's operating personnel will provide assistance in the field testing.

B. Inspection: The Contractor shall inform the local authorities, such as building and plumbing inspectors, fire marshal, OSHA inspectors, and others, to witness required tests for piping, plumbing, fire protection systems, pressure vessels, safety systems, cranes, and related items to obtain required permits and certificates, and shall pay inspection fees.

C. Quality and Tolerances: Tolerances and clearances shall be as shown on the Shop Drawings and shall be closely adhered to.

D. Machine Work shall be of high-grade workmanship and finish, with due consideration to the special nature or function of the parts. Members or machine parts without machined or milled ends and which are to be framed to other steel parts of the structure may have a variation in the detailed length of not greater than 1/16-inch for members 30-feet or less in length, and not greater than 1/8-inch for members over 30-feet in length.

E. Castings shall be homogeneous and free from non-metallic inclusions and defects. Surfaces of castings which are not machined shall be cleaned to remove foundry irregularities. Casting defects not exceeding 12.5 percent of the total thickness and where defects will not affect the strength and serviceability of the casting may be repaired by approved welding procedures. The Engineer shall be notified of larger defects. No repair welding of such defects shall be carried out without the Engineer's written approval. If the removal of metal for repair reduces the stress resisting cross-section of the casting by more than 25 percent or to such an extent that the computed stress in the remaining metal exceeds the allowable stress, then the casting may be rejected. Costs of casting new material shall be the Contractor's responsibility as part of the Work.

F. Materials shall meet the physical, chemical, metallurgical and mechanical properties in accordance with the reference standards. All materials or products shall be new and from a Manufacturer specializing in the manufacture of the product. All materials shall be high-grade, standard commercial quality, free from all defects and imperfection, and shall be recommended by the Manufacturer for the intended application.

G. Machine Finish: The type of finish shall be the most suitable for the application as recommended by the equipment manufacturer in micro-inches in accordance with ANSI B46.1 Surface Texture (Roughness, Waviness, Lay). In the absence of manufacturer's recommendations, the following surface finishes shall be used:

1. Surface roughness not greater than 63 micro-inches shall be required for surfaces in sliding contact.

2. Surface roughness not greater than 250 micro-inches shall be required for surfaces in contact where a tight joint is not required.

3. Rough finish not greater than 500 micro-inches shall be required for other machined surfaces.

4. Contact surfaces of shafts and stems which pass through stuffing boxes and contact surfaces of bearings shall be finished to not greater than 32 micro-inches.

H. Manufacturer's Experience: Equipment manufacturer shall have a record of proven experience of at least 5 years of successful, trouble-free operation in similar applications, type, model and size equal or larger than the equipment specified in this Contract. Where indicated in each individual equipment specifications, the Contractor shall submit this experience record to the Engineer for approval.

I. Warranty: Comply with the warranty requirements outline in Division 0. In addition, provide manufacturer's special warranty on materials or services as described in the individual technical specifications.

J. Certificates

1. Submit all equipment certificates to demonstrate that the equipment met provisions of specification in performance, materials, function, controls and operation as specified in each specific equipment specification sections.

K. Manufacturer's Instructions

1. Submit equipment manufacturer's instruction documenting packaging, shipping and delivery, storage, installation, startup, and operation and maintenance.

L. Source Quality Control Submittals

1. Submit source quality control procedures for foundry, machining, welding assembly and field installation in accordance with ISO 9001 Quality Procedures. Include non-destructive testing procedures as required to demonstrate and ensure quality of finished product. Equipment manufacturer shall be responsible of enforcing quality assurance procedures to producers for sub-manufactured parts.

M. Field Quality Control Submittals

1. Submit field quality control procedures for equipment from installation, startup and commissioning. Quality control procedure shall clearly describe specification performance requirement, function and controls, checkout steps, sign-off by Inspector. Submit test results and certificate signed by the equipment manufacturer representative, contractor and witnessed by the field engineer.

PART 2 -- PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Noise Level: When the equipment is in operation, no equipment shall exceed the following OSHA permissible noise exposure levels per day; 105 dBA for one hour, 100 dBA for two hours or 90 dBA for eight hours.

B. High Noise Level Location: The Contractor shall provide one personal hearing protection station at each location defined as follows:

1. Outdoor Location: Any single equipment item or any group of equipment items that produce noise exceeding OSHA noise permissible level for a 2-hour exposure. Where such equipment is separated by a distance of more than 20-feet, measured between edges of footings, the area for each group of equipment shall be provided with a separate hearing protection station.

2. Indoor Location

a. Any single equipment item or any group of equipment items located within a single room not normally occupied, that produces noise exceeding OSHA noise permissible level for a 2-hour exposure.

b. Any single equipment item or any group of equipment items located within a single room normally occupied by workers that produces noise exceeding OSHA noise permissible level for an 8-hour exposure.

C. Personal Hearing Protection: The Contractor shall furnish 3 pairs of high attenuation hearing protectors in the original unopened packaging. The ear protectors shall be capable of meeting the requirements of ANSI S12.6 and shall produce a noise level reduction of 25 dBA at a frequency of 500 Hz. The hearing protectors shall have fluid filled ear cushions and an adjustable, padded headband. The protectors shall be stored in a weatherproof, labeled, steel cabinet, provided at an approved location near the noise producing equipment.

D. Drive Trains and Service Factors: Service factors shall be applied in the selection or design of mechanical power transmission components. Components of drive train assemblies between the prime mover and the driven equipment shall be designed and rated to deliver the maximum peak or starting torque (whichever is the greatest), speed, and horsepower. Applicable service factors shall be considered, such as mechanical (type of prime mover), load class, start frequency, and temperature. Drive train components include couplings, shafts, gears, drive chains, sprockets, and V-belt drives. Unless otherwise indicated, the following load classifications shall apply in determining service factors:

Type of Equipment	**Service Factor**	**Load Classification**
Blowers		
centrifugal or vane	1.0	Uniform
lobe	1.25	Moderate Shock
Centrifugal Fans	1.0	Uniform
Reciprocating Air Compressors		
multi-cylinder	2.0	Heavy Shock
single cylinder	2.0	Heavy Shock
Pumps		
centrifugal or rotary	1.0	Uniform
reciprocating	1.8	Moderate Shock
progressing cavity	1.0	Uniform
Mixers		
constant density	1.0	Uniform
variable density	1.25	Moderate Shock
rapid mixer	1.25	Moderate Shock
flocculator	1.25	Moderate Shock
sludge mixer surface aerator	2.5 2.5	Moderate Shock Heavy Shock
Vacuum Filters	1.25	Moderate Shock
Cranes or Hoists	1.25	Moderate Shock

E. Mechanical Service Factors

	Mechanical Service Factors

	Electric Motor	Internal Combustion Engine
Uniform	1.25	1.50
Moderate Shock	1.50	1.75
Heavy Shock	2.00	2.25

F. For thermal rating adjustments such as start frequency, ambient temperature, and hourly duty cycle factor, ventilation factor, and fan factor, refer to the manufacturer sizing information.

G. Where load classifications are not indicated, the equipment manufacturer's recommendations for service factors shall be utilized.

H. Welding: Unless otherwise indicated, welding shall conform to the following:

1. Welding shall be by the metal-arc method or gas-shielded arc method as described in the American Welding Society's "Welding Handbook" as supplemented by other pertinent standards of the AWS. Qualification of welders shall be in accordance with the AWS Standards.

2. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained to minimize distortion and for control of dimensions. Weld reinforcement shall be as specified by the AWS code. Upon completion of welding, weld splatter, flux, slag, and burrs left by attachments shall be removed. Welds shall be repaired to produce a smooth and acceptable appearance with uniform weld contours and dimensions. Sharp corners of material that are to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

3. Composite fabricated steel assemblies that are to be erected or installed inside a hydraulic structure, including any fixed or movable structural components of mechanical equipment, shall have continuous seal welds to prevent corrosion of hard-to-coat metallic surfaces.

4. Welded steel tanks: Latest revision of AWWA D100.

5. Welded steel piping: Latest revision of AWWA C206.

I. Protective Coating: Equipment shall be painted or coated in accordance with Section 09 96 00.10 – High-Performance Coatings, unless otherwise indicated. Non-ferrous metal and corrosion-resisting steel surfaces shall be coated with grease or lubricating oil. Coated surfaces shall be protected from abrasion or other damage during handling, testing, storing, assembly, and shipping.

J. Potable Water Contact: Materials immersed in or exposed to potable water shall be made of materials or coated compliant with NSF/ANSI 61. Bronze alloy materials in contact with potable water shall be constructed of zero-lead materials or materials whose lead content do not exceed the weighted average criteria as required by the Lead Reduction Act. Equipment manufacturer shall submit to the Engineer a certification of compliance with the requirement of NSF Standard 61 and the Lead Reduction Act.

K. Protection of Equipment: Machined and coated surfaces shall be protected by rust inhibitor material prior to shipment. Equipment shall be boxed, crated, or otherwise protected from damage and moisture during shipment, handling, and storage. Equipment shall be protected from exposure to corrosive fumes and shall be kept thoroughly dry. Equipment with anti-friction bearings or sleeve bearings shall be protected from being damaged due to jarring motion during shipment. Pumps, motors, drives, electrical equipment, and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities prior to installation. For extended storage periods, plastic equipment wrappers should be avoided to prevent accumulation of condensate in gears and bearings. In addition, motor space heaters shall be energized, and shafts shall be rotated per manufacturer's recommendation. Equipment delivered to the Site with rust or corroded parts shall be rejected. If equipment develops defects during storage, it shall be disassembled, cleaned, recoated, or otherwise corrected to restore it to original condition.

L. Identification of Equipment Items

1. At the time of shipping, each item of equipment shall have a legible identifying mark corresponding to the equipment number in the Contract Documents for the particular item.

2. After installation, each item of equipment shall be given permanent identification.

a. Pumps, compressors, and blowers of 150 horsepower or less shall receive acrylic plastic or stainless steel plate nametags.

b. Pumps, compressors, and blowers larger than 150 horsepower shall receive stainless steel plate nametags.

M. Vibration Isolators: Air compressors, blowers, engines, inline fans shall be provided with restrained spring-type vibration isolators or pads per manufacturer's written recommendations. Vibration isolations shall be provided with seismic restraint.

N. Equipment Maximum Allowable Vibration Level: Unless otherwise indicated, maximum allowable vibration level shall be in accordance with the acceptance criteria recommended by the reference Standard for that particular type of equipment

O. Shop Fabrication: Shop fabrication shall be performed in accordance with the Contract Documents and the Shop Drawings.

P. Controls: Equipment and system controls shall be in accordance with Division 40 - Instrumentation.

Q. American Iron and steel requirements apply. See Section C-007 – General Conditions.

2.2 EQUIPMENT SUPPORTS AND FOUNDATIONS

A. Equipment Supports: Equipment components and supports, anchors, and seismic restrainers shall be adequately designed for static, dynamic, wind, and seismic loads. The design horizontal seismic force shall be the greatest of the following design criteria:

1. Design Criteria noted in Section 01 33 17 – Structural Design, Support, and Anchorage.

B. Submit design calculations for equipment supports, anchors, and seismic restrainers signed and sealed by an engineer registered in the State wherein the project is to be built. Calculations shall account for forces and distribution of forces on supporting structures resulting from normal operation, normal operation plus seismic loadings, and normal operation plus wind loadings in accordance with Section 01 33 17 – Structural Design, Support, and Anchorage.

1. Wall-mounted equipment weighing more than 250 pounds, or which is within 18-inches above the floor shall be provided with fabricated steel supports. Pedestals shall be of welded steel. If the supported equipment is a panel or cabinet or is enclosed with removable sides, the pedestal shall match the supported equipment in appearance and dimensions.

2. Seismic requirements: Freestanding and wall-hung equipment shall be anchored in place by methods that satisfy Section 01 33 17 – Structural Design, Support and Anchorage. Calculations shall be performed and signed and stamped for equipment weighing more than 400 pounds. Calculations shall analyze lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

3. Wind requirements: Exterior freestanding equipment shall be anchored in place by methods that satisfy Section 01 33 17 – Structural Design, Support and Anchorage. Calculations shall be performed and signed and stamped, analyzing lateral and overturning forces and shall include a factor of safety against overturning equal to 1.5. Calculations shall include the distribution of forces imposed on the supporting structure and anchors, verifying that each anchor can develop the required resistance forces.

4. Anchors: Anchor bolts shall be in accordance with Section 05 50 00 – Metal Fabrications. Contractor shall determine the size, type, capacity, location, and other placement requirements of anchorage elements. Anchoring methods and leveling criteria in the manufacturer's literature shall be followed. Submit methods and criteria with the Shop Drawings.

5. Equipment Grout: Mechanical equipment installed on top of concrete foundations or bases shall be provided with non-shrink concrete or epoxy grout as indicated and as specified in Section 03 60 00 – Grouting. Grout shall be applied between the base plate and the concrete foundation or base in accordance with the grout manufacturer’s recommendation. Grout shall be free of void space.

2.3 COUPLINGS

A. Mechanical couplings shall be provided between the driver and the driven equipment. Flexible couplings shall be provided between the driver and the driven equipment to accommodate slight angular misalignment, parallel misalignment, end float, and to cushion shock loads. Unless otherwise indicated or recommended by the equipment manufacturer, coupling type shall be furnished with the respective equipment as follows:

Equipment Type	**Coupling Type**
Horizontal and end suction pumps	Gear or flexible spring

Equipment Type	Coupling Type
Vertical turbine pumps	3-piece spacer for solid shaft or double nut for hollow shaft
Vertical nonclog pumps, close coupled	Flexible disc pack
Screw pumps	Flexible spring, gear coupling, fluid coupling
Vertical nonclog pumps with extended shaft	Flexible disc pack
Single stage centrifugal blowers	Flexible disc pack
Air compressors	Gear or flexible disc pack

B. Each coupling size shall be determined based on the rated horsepower of the motor, speed of the shaft, and the load classification service factor. The Contractor shall have the equipment manufacturer select or recommend the size and type of coupling required to suit each specific application.

C. Differential Settlement: Where differential settlement between the driver and the driven equipment may occur, 2 sets of flexible disc pack couplings or as recommended by equipment manufacturer shall be provided.

D. Taper-Lock or equal bushings may be used to provide for easy installation and removal of shafts of various diameters.

2.4 SHAFTING

A. General: Equipment manufacturer shall be responsible for designing and manufacturing shafting to carry all loads applied to the shaft. Shafting shall be continuous between bearings and shall be sized to transmit the power required. Keyways shall be accurately cut in line. Shafting shall not be turned down at the ends to accommodate bearings or sprockets whose bore is less than the diameter of the shaft. Shafts shall rotate in the end bearings and shall be turned and polished, straight, and true.

B. Design Criteria: Shafts shall be designed to carry the steady state and transient loads suitable for unlimited number of load applications.

C. Materials: Shafting materials shall be compatible with the type of service and load transmitted. Environmental elements such as corrosive gases, moisture, and fluids shall be taken into consideration. Materials shall be as indicated unless furnished as part of an equipment assembly.

1. Low carbon cold-rolled steel shafting shall conform to ASTM A 108, Grade 1018.

2. Medium carbon cold-rolled shafting shall conform to ASTM A 108, Grade 1045.

3. Other grades of carbon steel alloys shall be suitable for service and load.

4. Corrosion-resistant shafting shall be stainless steel or Monel, whichever is most suitable for the intended service.

2.5 GEARS AND GEAR DRIVES

A. Unless otherwise indicated, gears shall be of the spur, helical, or spiral-bevel type, designed and manufactured in accordance with AGMA Standards, with a service factor suitable for load class, mechanical service and thermal rating adjustment, a minimum L-10 bearing life of 60,000 hours, and a minimum efficiency of 94 percent. Peak torque, starting torque, and shaft overhung load shall be checked when selecting the gear reducer. Worm gears shall not be used unless specifically approved by the Engineer.

B. Gear speed reducers or increasers shall be of the enclosed type, oil- or grease-lubricated and fully sealed, with a breather with humidity control filter to allow air to escape but keep moisture, dust and dirt out. The casing shall be of cast iron, ductile iron, or heavy-duty steel construction with lifting lugs and an inspection cover for each gear train. An oil level sight glass and an oil flow indicator shall be provided, located for easy reading.

C. Gears and gear drives that are part of an equipment assembly shall be shipped fully assembled for field installation.

D. Material selections shall be selected by the manufacturer, provided the above AGMA values are met. Input and output shafts shall be adequately designed for the service and load requirements. Gears shall be computer-matched for minimum tolerance variation. The output shaft shall have 2 positive seals to prevent oil leakage.

E. Oil level and drain locations shall be easily accessible. Oil coolers or heat exchangers with required appurtenances shall be provided when necessary.

F. Where gear drive input or output shafts from one manufacturer connect to couplings or sprockets from a different manufacturer, the Contractor shall have the gear drive manufacturer furnish a matching key taped to the shaft for shipment.

2.6 DRIVE CHAINS

A. Power drive chains shall be commercial type roller chains meeting ASME Standards.

B. A chain take-up or tightener shall be provided in every chain drive arrangement to provide easy adjustment.

C. A minimum of one connecting or coupler link shall be provided in each length of roller chain.

D. Chain and attachments shall be of the manufacturer's best standard material and be suitable for the process fluid.

2.7 SPROCKETS

A. General: Sprockets shall be used in conjunction with chain drives and chain-type material handling equipment.

B. Materials: Unless otherwise indicated, materials shall be as follows:

1. Sprockets with 25 teeth or less, normally used as a driver, shall be made of medium carbon steel in the 0.40 to 0.45 percent carbon range.

2. Type A and B sprockets with 26 teeth or more, normally used as driven sprockets, shall be made of minimum 0.20 percent carbon steel.

3. Large diameter sprockets with Type C hub shall be made of cast iron conforming to ASTM A 48, Class 30.

C. Sprockets shall be accurately machined to ASME Standards. Sprockets shall have deep hardness penetration in tooth sections.

D. Finish bored sprockets shall be furnished complete with key seat and set screws.

E. To facilitate installation and disassembly, sprockets shall be of the split type or shall be furnished with Taper-Lock bushings as required.

F. Idler sprockets shall be provided with brass or Babbitt bushings, complete with oil hole and axial or circumferential grooving with stainless steel tubing and grease fitting extended to an accessible location. Steel collars with set screws may be provided in both sides of the hub.

2.8 V-BELT DRIVES

A. V-belts and sheaves shall be of the best commercial grade and shall conform to ASME, MPTA, and RMA Standards.

B. Unless otherwise indicated, sheaves shall be machined from the finest quality gray cast iron.

C. Sheaves shall be statically balanced. In some applications where vibration is a problem, sheaves shall be dynamically balanced. Sheaves operating at belt speeds exceeding 6,500 fpm may be required to be of special materials and construction.

D. To facilitate installation and disassembly, sheaves shall be provided complete with Taper-Lock or QD bushings as required.

E. Finish bored sheaves shall be complete with key seat and set screws.

F. Sliding motor bases shall be provided to adjust the tension of V-belts.

2.9 DRIVE GUARDS

A. Power transmission trains, prime movers, machines, shaft extensions, and moving machine parts shall be guarded to conform to the Division of Industrial Safety General Industrial Safety Orders latest edition. The guards shall be constructed of minimum 10-gauge expanded, flattened steel with smooth edges and corners, galvanized after fabrication, and securely fastened. Where required for lubrication or maintenance, guards shall have hinged and latched access doors.

2.10 BEARINGS

A. General: All bearings shall be selected and sized by the equipment manufacturers and reviewed by bearing manufacturers. Bearing life calculation shall be submitted and reviewed by bearing manufacturer. Bearing shall conform to the standards of the American Bearing Manufacturers Association, Inc. (ABMA).

B. To assure satisfactory bearing application, ambient temperature, humidity, internal clearances, fitting practice, mounting, lubrication, sealing, static rating, housing strength, and lubrication shall be considered in bearing selection.

C. Re-lubricatable type bearings shall be equipped with hydraulic grease fitting in an accessible location and shall have sufficient grease capacity in the bearing chamber.

D. Lubricated-for-life bearings shall be factory-lubricated with the manufacturer's recommended grease to insure maximum bearing life and best performance.

E. Anti-Friction Type Bearing Life: Except where otherwise indicated, bearings shall have a minimum L-10 life expectancy of 5 years or 20,000 hours, whichever occurs first. Where so indicated, bearings shall have a minimum rated L-10 life expectancy corresponding to the type of service, as follows:

Type of Service	**Design Life, years**	**L-10 Design Life, hours**
	(whichever comes first)	
8-hour shift	10	20,000
16-hour shift	10	40,000
Continuous	10	60,000

F. Bearing housings shall be of cast iron or steel and bearing mounting arrangement shall be as indicated or as recommended in the published standards of the manufacturer. Split-type housings may be used to facilitate installation, inspection, and disassembly.

G. Sleeve Type Bearings: Sleeve-type bearings shall have a cast iron or ductile iron housing and Babbitt or bronze liner. Bearing housing shall be bolted and doweled to the lower casing half. These housings shall be provided with cast iron caps bolted in place and the bearing end caps shall be bored to receive the bearing shells. Sleeve bearings shall be designed on the basis of the maximum allowable load permitted by the bearing manufacturer. If the sleeve bearing is connected to an equipment shaft with a coupling, the coupling transmitted thrust will be assumed to be the maximum motor or equipment thrust. Lubricant, lubrication system, and cooling system shall be as recommended by the bearing manufacturer.

H. Plate Thrust Bearings: Thrust bearings shall be the Kingsbury Type, designed and manufactured to maintain the shaft in the fixed axial position without undue heating or the necessity of adjustment or attention. Bearings shall be oil lubricated to suit the manufacturer's standard method of lubrication for the specific bearing. If bearing cooling is required, manufacturer shall provide heat exchangers, incluging necessary intrumentation and controls, piping, filters, and valves.

2.11 PIPING CONNECTIONS

A. Pipe Hangers, Supports, and Guides: Pipe connections to equipment shall be supported, anchored, and guided to avoid stresses and loads on equipment flanges and equipment. Supports and hangers shall be in accordance with Section 40 05 07 – Pipe Supports.

B. Flanges and Pipe Threads: Flanges on equipment and appurtenances shall conform to ASME B16.1, Class 125, or B16.5, Class 150, unless otherwise indicated. Pipe threads shall be in accordance with ASME B1.20.1 and Section 40 05 01 – Piping General.

C. Flexible Connectors: Flexible connectors shall be installed in piping connections to engines, blowers, compressors, and other vibrating equipment and in piping systems in accordance with the requirements of Section 40 05 01 – Piping General. Flexible connectors shall be harnessed or otherwise anchored to prevent separation of the pipe where required by the installation.

D. Insulating Connections: Insulating bushings, unions, couplings, or flanges, as appropriate, shall be used in accordance with the requirements of the specifications.

2.12 GASKETS AND PACKINGS

A. Gaskets and packings shall be in accordance with the requirements of the specifications. Gaskets and packings in contact with drinking water shall be NSF 61 approved. Elastomeric materials in contact with water with chloramines, or water with ozone residual shall be made of Teflon or Viton-A, or equal.

B. Packing around valve stems and reciprocating shafts shall be of compressible material, compatible with the fluid being used. Chevron-type "V" packing shall be Garlock No. 432, John Crane Everseal, or equal.

C. Packing around rotating shafts (other than valve stems) shall be "O" rings, stuffing boxes, or mechanical seals, as recommended by the manufacturer and approved by the Engineer, in accordance with Section 43 21 00 – Pumps, General.

2.13 NAMEPLATES

A. Equipment nameplates of stainless steel shall be engraved or stamped and fastened to the equipment in an accessible location with No. 4 or larger oval head stainless steel screws or drive pins. Nameplates shall contain the manufacturer's name, model, serial number, size, characteristics, and appropriate data describing the machine performance ratings.

2.14 SPECIAL TOOLS AND SPARE PARTS

A. Tools: The Contractor shall furnish two complete set of special wrenches and other special tools necessary for the assembly, adjustment, and dismantling or maintenance of the equipment. Tools shall be of best quality hardened steel forgings with bright finish. Wrench heads shall have work faces dressed to fit nuts. Tools shall be suitable for professional work and manufactured by Snap On, Crescent, Stanley, or equal. The set of tools shall be neatly mounted in a labeled toolbox of suitable design provided with a hinged cover.

B. Spare parts shall be furnished as indicated in the individual equipment sections. Spare parts shall be suitably packaged in a metal box and labeled with equipment numbers by means of stainless steel or solid plastic nametags attached to the box.

2.15 EQUIPMENT LUBRICANTS

A. The Contractor shall provide lubricants for equipment during shipping, storage, and prior to testing, in accordance with the manufacturer's recommendations. Lubricants that could come in contact with potable water shall be food grade lubricants. After successful initial testing, final testing, and satisfactory completion startup testing per Section 01 75 00 - Equipment Testing and Plant Startup, the Contractor shall conduct one complete lubricant change on equipment. In addition, the Contractor shall be responsible for the proper disposal of used lubricants. The Owner will then be responsible for subsequent lubricant changes.

PART 3 -- EXECUTION

3.1 SERVICES OF MANUFACTURER

A. Installation Supervision, Inspection, Startup, and Field Adjustment: An authorized, experienced, and competent service representative of the manufacturer shall visit the Site to perform the following:

1. Supervision of the installation of the equipment.

2. Inspection, checking, and adjusting the equipment and approving its installation.

3. Startup and field testing for proper operation, efficiency, and capacity.

4. Performing field adjustments during the test period to ensure that the equipment installation and operation comply with requirements.

5. Verify, affirm and certify that the specified equipment performance acceptance criteria and conditions such as temperature and vibration amplitude, have been met. Submit test certificate signed by the Contractor and witnessed by the Engineer representative.

6. Certify in writing that the equipment and controls have been properly installed, aligned, lubricated, adjusted, and readied for operation.

7. Unless otherwise indicated, factory representative shall be present at the job site for the number of days as indicated in each equipment Section.

B. Owner Staff Training

1. Owner staff training shall be in accordance with Section 01 79 00 – Owner Staff Training. An authorized training representative of the Manufacturer shall visit the site for a number of days indicated in those sections to instruct the Owner's personnel in the operation and maintenance of the equipment, including step by step troubleshooting with necessary test equipment. Instruction shall be specific to the models of equipment provided.

2. The representative shall have at least two years' experience in training. A resume of the representative shall be submitted.

3. Unless otherwise indicated, a minimum of one day of training shall be provided for each type of equipment.

3.2 EQUIPMENT TESTING

A. General requirements

1. All mechanical equipment shall undergo factory and field performance and functional test to demonstrate that the process equipment system meet the requirement of the Contract Document. Detailed testing requirement are specified in each equipment specification sections.

2. Unless otherwise specified, equipment factory testing procedure shall follow the Industry Standard test procedure that applies to that equipment.

3. Submit test procedures for review by the engineer one month prior to the scheduled test.

B. Test sequence

1. Factory functional and performance testing

2. Component tests

3. System tests

4. Individual system or train test

5. Overall facility operational tests

3.3 INSTALLATION

A. General: Equipment shall be installed in accordance with the manufacturer's written recommendations.

B. Alignment: Equipment shall be field tested to verify proper alignment.

3.4 STARTUP AND COMMISSIONING

A. Startup and commissioning tests shall be as specified in 01 75 00 – Equipment Testing and Plant Startup.

3.5 PACKAGED EQUIPMENT

A. When any system is furnished as pre-packaged equipment, the Contractor shall coordinate space and structural requirements, clearances, utility connections, signals, and outputs with Subcontractors to avoid later change orders.

B. If the packaged system has any additional features (such as safety interlocks, etc.) other than required by the Contract Documents, the Contractor shall coordinate such features with the Engineer and provide material and labor necessary for a complete installation as required by the manufacturer.

3.6 FIELD ASSEMBLY

A. Studs, cap screws, bolt and nuts used in field assembly shall be coated with Never Seize compound or equal.

3.7 WELDING

A. Welds shall be cleaned of weld-slag, splatter, etc. to provide a smooth surface

3.8 FIELD TESTING

A. Where indicated by the individual equipment sections, equipment shall be field tested after installation to demonstrate satisfactory operation without excessive noise, vibration, or overheating of bearings or motor.

B. The following field testing shall be conducted:

1. Operational Readiness Tests (ORT)

a. Check equipment for proper installation, baseplates leveled, grouted and anchor bolts properly torqued to manufacturer's specifications and rotating assemblies balanced and shafts aligned.

b. Install all instruments and their associated components, controls panels, wirings are installed, calibrated and termination checked.

c. Install and check all PLC's, Input/output wires and all terminations.

d. Install all power cables from MCC to motors and checked.

2. Perform trial operation. Start equipment, check, and operate the equipment over its entire operating range. Vibration level shall be within the amplitude limits as indicated or as recommended by the reference applicable standards.

3. Obtain concurrent readings of motor voltage, amperage, capacity, vibration, and bearing temperatures.

4. Operate equipment indicated in Section 01 75 00 – Equipment Testing and Plant Startup.

C. The Engineer shall witness field-testing. The Contractor shall notify the Engineer of the test schedule 7 Days in advance.

D. In the event that any equipment fails to meet the test requirements, the equipment shall be modified and retested until it satisfies the requirement.

END OF SECTION

SECTION 46 30 00 - CHEMICAL FEEDING EQUIPMENT, GENERAL

PART 1 -- GENERAL

1.1 THE SUMMARY

A. Provide chemical feeding equipment, complete and operable, as indicated in accordance with the Contract Documents.

B. Provide equipment from manufacturers with several years of experience in the manufacture and assembly of similar products, and with a record of successful installations.

C. Such manufacturers shall maintain a well-established, authorized, and local service agency with sufficient spare parts and personnel to respond within 48 hours to a service call.

D. The requirements of Section 46 10 00 – Equipment General Provisions apply to the WORK of this Section.

E. Unless indicated otherwise, the requirements of this Section apply to all chemical feeding equipment in the Project.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

1.3 SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Submit complete fabrication, assembly, foundation, and installation drawings, together with detailed specifications and data covering materials to be used, power drive assemblies, parts, devices, pumps, tanks, mixers, supports, panels, and other accessories forming a part of the equipment, plus schematics, diagrams, and panel layouts.

C. Certification

1. Obtain written certification from the manufacturer, addressed to the Owner, stating that:

a. the equipment will efficiently and thoroughly perform the required functions in accordance with the Contract Documents;

b. the materials are best suited for the chemicals handled; and,

c. the manufacturer accepts joint responsibility with the Contractor for coordination of equipment, including motors, variable speed drives, controls, and services required for proper installation and operation of the completely assembled and installed unit.

D. Technical Manuals

1. Furnish complete operations and maintenance manuals prior to start-up. See Section 01 73 00 – Installation, Operation, and Maintenance Manuals.

E. Spare Parts List

1. Obtain from the manufacturer a list of suggested spare parts for each piece of equipment subject to wear, such as seals, packing, gaskets, nuts, bolts, washers, wear rings, and the like.

F. Maintenance

1. Submit printed instructions relating to proper maintenance, including lubrication, and parts lists indicating the various parts by name, number, and diagram where necessary.

2. Submit the information in duplicate with each unit or set of identical units.

G. Field Procedures Information

1. Submit instructions for field procedures for installation, adjustments, inspection, and testing prior to installation of the equipment.

H. Calibration Graphs

1. The manufacturer's representative shall prepare a calibration graph from field tests for each chemical feed unit that does not have a rate set device.

2. The graphs shall read in pounds per hour for dry feeders or in gallons per hour for liquid feeders.

3. The graphs shall show the rate setter graduation conversion to pounds per hour or gallons per hour throughout the range of the feed unit.

4. Furnish each graph on hard paper and seal in clear plastic.

1.4 GUARANTEES AND WARRANTIES

A. After completion, furnish to the Owner the manufacturer's written guarantees that the equipment will operate with the published efficiencies, heads, criteria, and flow ranges, as well as meeting the indicated requirements.

B. Furnish the manufacturer's warranties as published in its literature.

C. Comply with warranty requirements outlined in Division 0.

1.5 SEISMIC DESIGN REQUIREMENTS

A. Designs shall conform to the seismic requirements as specified in Section 01 33 17 – Structural Design, Support and Anchorage and Section 46 10 00 – Equipment General Provisions.

PART 2 -- PRODUCTS

2.1 GENERAL

A. Wherever it is required that a single manufacturer shall be responsible for the compatible and successful operation of the various components of an equipment unit, it shall be understood to mean that the Contractor shall provide only such equipment as the designated manufacturer will certify is suitable for use with its equipment and with the further understanding that this in no way constitutes a waiver of any indicated requirements.

B. Where 2 or more units of the same type or size of equipment are required, such units shall be produced by the same manufacturer.

2.2 MATERIALS

A. General

1. Materials used in the equipment shall be suitable for the intended application.

2. Materials not specifically called for shall be of high-grade, standard commercial quality, free from defects and imperfections that might affect the serviceability of the product for the purpose for which it is intended.

B. Corrosion Resistance

1. Materials used in the construction of chemical feeding equipment shall be resistant to corrosive attack from the chemicals.

2. The following table lists the most commonly used chemicals for water and wastewater treatment and some of the suitable materials for the construction of chemical feeding equipment.

3. Unless the manufacturer proposes more suitable materials, adhere to the materials listed in the table.

CHEMICAL	**SUITABLE HANDLING MATERIAL**
Aluminum Chlorohydrate ($AlCl_3$ $6H_2O$)	Carpenter 20 (10 percent solution) Hastelloy B FRP PVC Vinyl Saran Hypalon

	Teflon Tyril Rubber Ceramic
Chlorine Solution	Titanium PVC FRP (verify with FRP manufacturer) Viton Saran Teflon Polyethylene
Citric Acid	Buna N (Nitril) Carpenter 20 EPDM Hastelloy-C Natural Rubber Neoprene, Nylon PTVE PVDF Viton
Calcium Thiosulfate	Alloy 20 Hastelloy-C PVC CPVC PVDF PTFE Hypalon Viton EPDM
Sodium Chloride (NaCl)	Carpenter 20 Hastelloy C Titanium PVC FRP (verify with FRP manufacturer) Kynar Teflon Hypalon Saran Vinyl Tyril

	Glass
Sodium Hydroxide (NaOH) (Caustic Soda)	PVC, CPVC Teflon EPDM Hypalon Polypropylene
0.8% Sodium Hypochlorite (NaOCl)	Hastelloy C Titanium PVC Viton Penton Hypalon Vinyl Saran Polyethylene Tyril Glass

2.3 APPURTENANCES

A. Nameplate

1. Provide each piece of equipment with a stainless steel nameplate, indicating equipment characteristics, capacity, motor horsepower, speed, electrical characteristics, manufacturer, model number, and serial number.

B. Solenoid Valves

1. The equipment manufacturer shall provide solenoid valves which are part of the chemical feeding unit.

2. The solenoid valve electrical rating shall be compatible with the equipment voltage.

3. Provide the valves complete with the necessary conduit and wiring from the control panel to the solenoids.

4. The valve material shall be suitable for the intended service and in accordance with the requirements Section 43 30 52 – Miscellaneous Valves.

C. Pressure Gauges

1. Where indicated, provide chemical transfer and metering pumps and other equipment with pressure gauges with diaphragm seals, in accordance with Section 40 73 00 – Pressure, Strain, and Force Measurement , except that the size of gauges on small metering pumps may be smaller than indicated in that Section, as approved by the Engineer.

D. Pressure Switches

1. Where indicated, provide chemical transfer, metering pumps, and other equipment with chemical service pressure switches and diaphragm seals.

2. Provide the pressure switches in accordance with the requirements of Section 40 73 36 – Pressure and Differential Pressure Switches.

E. Equipment Supports

1. Firmly support and anchor chemical feeding equipment and piping on concrete equipment pads.

2. Fabricate metal supports exposed to chemical spills from Type 316 stainless steel or enameled steel.

3. Anchor bolts, nuts, and washers of such supports shall be constructed of Type 316 stainless steel, with an anti-seize compound provided on the threads.

F. Variable Speed Drives

1. Variable speed drives, drive motors, speed control equipment, and accessories shall be furnished in accordance with the requirements of Section 26 29 23 – Variable Frequency Drive Units.

G. Controls

1. House the controls in enclosures with NEMA ratings which comply with the area designations of Section 26 00 00 - Electrical Work, General.

H. Safety Equipment

1. Where required by code, provide chemical unloading, storage, and feeding equipment with the necessary safety devices and warning signs, clearly visible.

I. Heating Cable

1. Where electric heat trace cable is required for proper operation of the system, comply with Section 26 05 50 – Electric Heat Tracing.

2. Provide self-regulating cable with a 150-degree F maintenance temperature, 120-volt, 3 watts per foot output, and twin 16 AWG copper buss wires within an insulated jacket.

3. After pipe and tanks are heat traced, insulate them with exterior jacketing applied in accordance with the requirements of Section 43 07 00 – Process Piping and Equipment Insulation.

J. Spill Containment Pallett

2.4 TOOLS AND SPARE PARTS

A. Tools

1. Furnish the following:

a. Special tools as necessary for maintenance and repair of the equipment; and,

b. One pressure grease gun for each type of grease required for the equipment.

2. Such tools shall be suitably stored in metal tool boxes, and identified with the equipment number by means of stainless steel or solid plastic name tags attached to the box.

B. Spare Parts

1. Furnish spare seals, packing, gaskets, wear rings, and bearings as required in the feed equipment specification Section.

2.5 CHEMICAL TOTE CONTAINMENT SYSTEM

A. General: The Owner shall be responsible to provide chemical totes after successful plant startup and testing in accordance with Section 01 75 00 – Equipment Testing and Plant Startup. The Contractor shall furnish chemical tote containment systems as specified herein.

B. SPILL CONTAINMENT TOTE SCALES

1. The Contractor shall furnish a loose spill containment pad and tote scale as part of the chemical feed system.

Equipment number	30-TK-0601
Chemical stored	Citric Acid
Concentration, percent	50
Unit weight, lb/gal	8.35
Specific gravity	1.24
pH	<2
Viscosity, centipoise at 77 deg. F	7
Capacity, gallon	330

2. Each unit shall be a standard IBC spill palette with sufficient containment volume for the tote(s) it serves. Each unit shall include an integral scale (measuring the weight of remaining net chemical to 0.5% accuracy) connected to a remote mounted NEMA 4X weight indicating transmitter. Transmitter shall transmit a 4-20 mA output signal proportional to the calibrated scale readings.

3. Spill containment tote scales shall be Force Flow WIZARD 4000 Tote Scale, Scaletron Model 4042-63, or Engineer Approved equal.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. General

1. Install the chemical feeding equipment in accordance with governing safety standards, the Shop Drawings, and as indicated.

B. Alignment

1. Field-test the equipment in order to verify:

a. proper alignment;

b. proper operation; and,

c. freedom from binding, scraping, vibration, shaft run-out, leaks, and other defects.

2. Measure drive shafts just prior to assembly in order to ensure correct alignment without forcing.

3. Secure the equipment in position and in a neat appearance.

C. Lubricants

1. Furnish the necessary oil and grease for initial lubrication and testing of the equipment.

3.2 MANUFACTURER'S SERVICE REPRESENTATIVE

A. Installation and Start-up Assistance

1. Furnish service and instruction assistance by the manufacturer's engineering representative for each equipment unit, during the following period:

a. One day during installation, unless indicated otherwise in the feed equipment specification Section.

b. One day during startup, unless indicated otherwise in the feed equipment specification Section.

B. Instruction of Owner's Personnel

1. Furnish the services of a factory-authorized service representative to instruct the Owner’s personnel in the operation and maintenance of the equipment.

2. Furnish a minimum of a one-day visit to the Project for each type of similar equipment.

END OF SECTION

SECTION 46 32 00 – SODIUM HYPOCHLORITE GENERATION SYSTEM

PART 1 -- GENERAL

1.1 THE SUMMARY

A. This Section covers the work necessary by the Contractor and On-site Sodium Hypochlorite Generation System (OSHG) Supplier, to furnish, install, test, and make ready for operation of an OSHG.

B. The Equipment Supplier shall furnish an OSHG system to enable on-site production of a 0.8% (+/- 0.05%) sodium hypochlorite solution through the electrolysis of sodium chloride brine.

C. The minimum total generation capacity of each skid shall be 20 pounds of equivalent chlorine per day. This capacity shall be achieved using two (2) hypochlorite generation skids operating in a duty, standby configuration. Each skid shall be capable of producing 20 pounds of equivalent chlorine per day.

D. The scope of work shall include:

1. OSHG skid:

a. The units shall be furnished pre-piped, pre-wired and mounted on an engineered frame. At a minimum, the skid shall include the following components:

1) Sodium hypochlorite generators

2) Brine Feed Pump

3) Electrolyzer Cells

4) Pipe fittings and valves

5) Microprocessor-based Vendor Control Panel

6) Generator Instrumentation

7) Brine Dilution System

b. Conduit, wire, boxes, etc. integral to the OSHG components and between components in the same enclosure or on the same skid.

2. A dual-water softener system shall be furnished to supply softened water to the brine tank and hypochlorite generation skids.

3. A brine tank shall be furnished with a level control and brine collector as described in this Section.

4. A sodium hypochlorite storage tank shall be furnished with a hydrogen dilution blower, air flow monitor, pressure transducer, valves, and other required instrumentation as described in this Section.

5. A peristaltic type, dual-pump skid shall be furnished for chemical feeding to the raw water and filtered water injection points.

6. Accessories:

    a. Hydrogen Gas Leak Detector

    b. Product Strength Test Kit

    c. Hardness Test Kit

E. The skid shall be ready-to-use and factory tested unit.

1. Contractor shall furnish piping connections to and from the skid, and between components listed in this Section.

2. Contractor shall furnish power connections to and from the skid, and between components requiring power as listed in this Section.

F. The equipment supplier shall provide the following services to ensure the safe and efficient operation of the system:

1. Skid Factory Test

2. System commissioning and installation inspection

3. System start-up

4. System performance test

5. Operator training

G. The Contractor shall furnish all labor, materials, equipment and appurtenances required to install, test and place into satisfactory operation the system furnished by the equipment supplier, including, but not limited to:

1. Mechanical installation of system components, piping, piping supports, fittings, valves and appurtenances not specified herein, including a unistrut-type frame anchored to the floor to mount the OSHG skids.

2. Electrical installation of external system components, circuit breakers, transformers, raceways, fittings, conduits and cable trays, wires and cables, panel boards, metering devices, grounding systems, power factor correction capacitors and surge protection.

H. The OSHG Supplier shall inspect the installation of the OSHG, and any errors shall be corrected by the Contractor. Following the correction of all errors, the OSHG Supplier shall provide a Certification of Proper Installation for the OSHG.

I. The OSHG Supplier shall submit Shop Drawings required for the fabrication and installation of the OSHG equipment.

J. The OSHG Supplier shall be responsible for programming the OSHG package control software. The Contractor shall integrate the OSHG controls with the plant control system.

K. The OSHG Supplier shall perform functional, performance and start-up testing of the OSHG. The Contractor shall notify the OSHG Supplier at least 14 days before the scheduled date for performing these tests and shall coordinate testing requirements and scheduling with the Engineer.

L. The OSHG Supplier shall submit and Operation and Maintenance Manual and Maintenance Summary Forms for the OSHG. The O&M Manual and Forms shall be reviewed by the Contractor and issued to the Engineer for review and approval.

M. The OSHG Supplier shall train Owner's personnel and provide detailed instructions in the operation of the OSHG.

N. The OSHG Supplier shall furnish the services of a qualified field engineer to check installation, start-up and instruct operating personnel in the proper operation and maintenance of the equipment.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Refer to Section 46 10 00 - Equipment General Provisions and Section 46 30 00 - Chemical Feeding Equipment, General, for codes and standards applicable to this section.

1.3 STANDARD PRODUCTS

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall essentially duplicate products that have been in satisfactory use for at least 5 years prior to bid opening and installed in at least two (2) separate locations.

1.4 SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. The OSHG Supplier shall submit the following document for approval:

1. Supplier's literature and specifications including a complete description in sufficient detail to permit comparison with technical specifications.

2. Bill of Materials for each component of the system.

3. Dimensional drawings for each component of the system including anchor bolt layout, materials, size, weight, and performance data.

4. Process and Instrumentation Diagrams (P&IDs) showing locations of all instruments, valves, auxiliary equipment and process loop descriptions. P&IDs shall show all supplied equipment including clear indication of tie in points.

5. Drawings showing fabrication, assembly, installation network, and wiring diagram. Wiring diagrams shall consist of, at a minimum, of control schematics, including

coordination with other electrical control devices operating in conjunction with the Sodium Hypochlorite generator feed system.

6. Pump Motor Data and pump curves

7. Affidavits of compliance with referenced standards and codes.

8. Process flow diagrams.

9. Electrical/Instrumentation submittals including:

    a. Interconnection diagrams

    b. Microprocessor-based Vendor Control Panel drawings

    c. Total connected load

    d. Detailed control descriptions

    e. Certified motor data sheet for each motor supplied.

10. Recommended spare parts list

11. The acceptable range of water pressure for proper system operation. If a pressure or flow regulator is required, it shall be provided.

12. NSF Certifications

13. Seismic anchorage calculations

14. Installation, Operation, and Maintenance Manual

    a. Complete, detailed operating instructions for each piece of equipment

    b. Explanations for all safety considerations relating to operations

    c. Recommended spare parts lists

    d. Maintenance data shall include all information and instructions required by plant personnel to keep equipment properly cleaned, lubricated and adjusted so that it functions economically throughout its full design life.

    e. Recommended schedule of maintenance tasks

    f. Troubleshooting instructions

    g. List of maintenance tools and equipment

    h. Name, address and phone number of manufacturer and manufacturer's local service representative.

15. Factory test results before shipment and field performance test results after installation.

16. A list of all parameters, ratings or other characteristics where the proposed OSHG deviates from the requirements set forth in the Contract Documents.

1.5 CODES AND STANDARDS

A. ANSI Z400.1 Hazardous Industrial Chemicals-Material Safety Data Sheets - Preparation

B. ASTM D 1785 Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120

C. AWWA B300 Hypochlorites

D. NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum)

E. NFPA 70 National Electrical Code

F. UL 50 Enclosures for Electrical Equipment

1.6 QUALITY ASSURANCE

A. The OSHG Supplier shall have experience in furnishing equipment of similar capacity and service capability to the equipment described herein.

B. As part of their submittal package, the Supplier shall submit the following:

1. Evidence that equipment of similar capacity and service capability has been in successful operation in at least five (5) separate installations within the continental United States in the last 5 years.

2. Current NSF Standard 61 Certification for the system being offered.

1.7 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall be responsible for the delivery, storage and handling of products in accordance with the Supplier's recommendations.

1.8 WARRANTY

A. Comply with this Section and warranty requirements outlined in Division 0.

B. The complete system shall be free of defects in materials and workmanship for a period of twelve (12) months from Final Acceptance if the system or eighteen (18) months from shipment, whichever occurs first.

C. Electrode plates shall be warranted for a period of seven (7) years.

1.9 SPARE PARTS AND SPECIAL TOOL

A. The Equipment Supplier shall furnish spare parts required to ensure adequate operation of the system including:

1. One (1) complete set of spare fuses

2. One (1) set of brine pump recommended spare parts

3. One (1) electrolytic cell level/temperature switch assembly

PART 2 -- PRODUCTS

2.1 GENERAL OSHG SKID REQUIREMENTS

A. Functional Requirements

1. Provide two (2) OSHG equipment units, each capable of producing a minimum of 20 pounds per day of 0.8% sodium hypochlorite.

2. A sodium hypochlorite solution with a concentration of 0.8% (+/- 0.1%) expressed as available chlorine shall be produced through the electrolysis of brine, consuming only water, salt and power in a hypochlorite generator. The minimum capacity shall be demonstrated to be equal to the capacity specified for each installation while not exceeding the maximum raw material quantities.

3. The OSHG skid shall include an electrolyzer cell(s), brine pump, water softener, control panel, and all required instrumentation, wiring, piping, valves, fittings and appurtenances to generate 20 lb/day of a 0.8% sodium hypochlorite solution.

4. The skid design shall allow for maintenance access for every component without the need to remove other components.

5. The skid shall be mounted onto a floor-mounted unistrut support brace, and shall not be wall-mounted.

   a. The Contractor shall furnish the support structure in accordance with the Drawings.

   b. The Contractor shall adhere to manufacturer's recommendations on spacing and clearance requirements for the OSHG units.

B. Materials

1. The skid base shall be corrosion resistant epoxy painted steel with a high-density polyethylene top cover.

2. Equipment and piping supports shall be corrosion resistant epoxy coated steel.

3. All interconnecting piping shall be schedule 80 PVC.

C. Features

1. The skid shall meet Seismic Zone 1 requirements.

D. Equipment Suppliers, or Equal: A single supplier shall provide all listed equipment and components in this Section. General layout, as shown on the drawings, is based on the vertical OSHG. The Contractor is responsible for any changes in equipment layout, pipework and additional accessories that may be required by the use of selected OSHG.

1. Evoqua Water Technologies (Wallace & Tiernan)

2. Microclor (PSI)

2.2 ELECTROLYZER CELLS

A. Functional Requirements

1. Each electrolyzer unit shall produce the equivalent of 20 pounds of chlorine per day.

2. The electrolyzer shall receive the following process streams: (a) diluted brine from the brine feed pump and (b) dilution water from the softener.

3. Electrical connections between the transformer/rectifier and electrolyzer shall be with cables designed for maximum current flow and maximum heat dissipation. The copper wire connections shall be fully insulated and protected with machined PVC end caps. Bare connections shall not be permitted.

4. The electrolyzer shall only produce hydrogen gas as a by-product of the reaction. Hydrogen gas shall be removed from the electrolyzer, diluted and vented to the atmosphere at the hypochlorite storage tank.

    a. Piping leaving the electrolyzers shall be routed in a continuous upwards slope to allow hydrogen gas to vent to the outside, per Drawings.

5. The electrolyzer shall operate at constant capacity and automatically start and stop based on the low and high level signals from the hypochlorite storage tank.

B. Materials

1. The electrolyzer casing shall be clear acrylic pipe or schedule 80 PVC. Both options shall be submitted, and Owner will choose their preference. The casing shall have removable PVC end caps to allow access to electrode plates.

2. The electrolyzer shall be mounted on the hypochlorite generator skid in a way that allows the off gassed hydrogen to rise and be removed from the electrolyzers and the containment piping.

    a. Piping leaving the electrolyzers shall be routed in a continuous upwards slope to allow hydrogen gas to vent to the outside, per Drawings.

3. Inside each electrolyzer cell, electrodes shall be mounted on a PVC/Titanium chassis.

4. Electrode plates shall be DSA type, with precious metal oxide coating on a titanium substrate, or equal to meet the design criteria.

C. Features

1. The electrolyzer shall include an integral electrolyte low level switch, to prevent operation of the system if the cell level is low.

2. The electrolyzer shall include an inner secondary dilution tube to allow for concentration and temperature control inside the electrolyzer. About 50% of the water consumed by the electrolyzer is fed through this dilution tube.

2.3 WATER SOFTENER

A. Functional Requirements

1. Potable water fed to the system shall first pass through a water softener to reduce the potential of hardness fouling of electrode surfaces inside the electrolyzer cells. The softened water shall be dispensed to both the brine saturator tank and hypochlorite generator.

2. One (1) dual-softener system shall be supplied for the entire system as per the equipment supplier's recommendation. The system shall be sized to reduce the hardness to < 17 mg/L as $CaCO_3$ for a maximum flow rate of 20 gpm.

3. The softeners shall be appropriate for continuous use with inlet water of the following quality:

   a. Water pressure (min – max): 25 to 125 psi

   b. Water temperature (min – max): 35 to 120 ^oF

   c. Water pH (min – max): 5 to 10

   d. Water hardness mg/L as $CaCO_3$ (max): 42 mg/L

   e. Chlorine residual: 2 mg/L (max)

4. The softener shall ensure an uninterrupted supply of softened water. The softener shall include two-(2) tanks (one set of twin tanks) and not be designed to operate in overdrive. Regeneration of one of the tanks shall be accomplished while the other tank is in use.

5. The regeneration cycle shall be based on water flow; electric timers and gear motors are not acceptable. The regeneration cycle should last a maximum of 11 minutes and consume a maximum of 14 gallons of saturated brine.

6. The softener shall use brine from the saturator tank for the regeneration cycle. The regeneration waste shall be disposed to a sanitary drain.

7. The water softener skid shall be position proximal to the onsite hypochlorite skid as shown in the Drawings.

B. Materials

1. The softener vessels material shall be engineered plastic.

2. The softener flow meter shall have a polypropylene turbine.

3. Softener connections shall be PVC.

C. Features

1. The softener vessels shall be designed for 125 psig maximum working pressure and hydrostatically tested @ 300 psig.

2. Vessels shall be NSF 61 approved.

2.4 SYSTEM CONTROL PANEL

A. Functional Requirements

1. One (1) Microprocessor-based Vendor Control Panel shall be furnished for the complete generator package to control and monitor the operation of the system.

2. The Vendor System Control Panel shall be mounted onto the sodium hypochlorite generation skids.

3. The control panel shall include:

   a. One (1) Allen Bradley or Equal with Ethernet & RS-232 Communication Ports

   b. The HMI (operator interface) shall be Allen Bradley model PanelView Plus 1000 Touch Screen or Equal

      1) Minimum display area 6” W x 5” H,

      2) Display shall be in Color

      3) Display shall be in English.

   c. Main disconnect

   d. Motor starter for brine pump

   e. Motor starters for blowers

4. The Vendor Control Panel shall receive the following discrete inputs:

   a. Rectifier Failure

   b. Rectifier Status

   c. Low Electrolyte Level

   d. Hydrogen Leak

   e. Low Air Flow

5. The Vendor Control Panel shall receive the following analog inputs:

   a. Rectifier Voltage

   b. Rectifier Current

   c. Saturated Brine Flow Rate

d. Water Flow Rate

e. Diluted Brine Temperature

f. Electrolyte Temperature

g. Hypochlorite Tank Level

6. The Vendor Control Panel shall include Intrinsic Barriers for the following inputs:

a. Diluted Brine Temperature

b. Electrolyte Temperature

c. Low Electrolyte Level

7. The Vendor Control Panel shall provide the following discrete outputs:

a. Rectifier Start/Stop

b. Brine Pump Start/Stop

c. Water Solenoid Valve Open/Close

d. Main Blower Start/Stop

e. Standby Blower Start/Stop

8. The following alarms as a minimum shall be displayed locally at the HMI:

a. Rectifier Failure

b. Rectifier Improper Voltage

c. Rectifier Improper Current

d. Low Saturated Brine Flow

e. Low Water Flow

f. Low Diluted Brine Temperature

g. High Diluted Brine Temperature

h. High Electrolyte Temperature

i. Low Electrolyte Level

j. Hydrogen Leak

k. Hypochlorite Tank Overflow

l. Hypochlorite Tank Low Level

m. Low Air Flow

n. Loss of Analog Signal

9. The following operating parameters shall be locally displayed at the Vendor Control Panel's HMI:

a. Rectifier Voltage

b. Rectifier Current

c. Rectifier Status

d. Brine Pump Status

e. Water Solenoid Valve Status

f. Diluted Brine Temperature

g. Electrolyte Temperature

h. Main Blower Status

i. Standby Blower Status

j. Hypochlorite Tank Level

10. The Vendor Control Panel shall provide the following volt-free contacts for remote monitoring:

a. System Error

b. System Ready

c. Preparation On

d. Dosing Enable

e. Stop Active

f. Recifiers Voltage

g. Rectifiers Current

h. Rectifiers Status

i. Electrolyte Cells Discharge Temperature Monitoring

j. Electrolyte Cells Discharge High Level Alarm

k. Hydrogen Monitoring

l. Hydrogen Leak Alarm

m. Sodium Hypochlorite Storage Tank Level Monitoring

n. Sodium Hypochlorite Storage Tank High Level Alarm

B. Materials

1. The control panel enclosure shall be 304 stainless steel NEMA 4X with lockable disconnect.

2. The control panel shall be built in accordance with UL 508 standards and shall be UL labeled.

C. Features

1. Control voltage shall be 120 V AC /24 V DC.

2.5 POWER TRANSFORMER/RECTIFIER

A. Functional Requirements

1. An SCR-type transformer/rectifier shall be furnished to provide DC power to each hypochlorite generator.

2. Input to transformer/rectifier shall be 240 V +/-5%, 3 PH, 60 Hz.

3. Output from transformer/rectifier shall be 1500 A @ 24 V DC. Power output from the transformer/rectifier shall be DC having less than 5% RMS ripple when under nominal range of operating conditions.

4. The transformer/rectifier shall have a minimum efficiency of 90% at rated output and normal operating conditions.

5. The transformer/rectifier shall be designed for a 100% duty cycle (24 hr/day & 7 days per week).

6. The transformer/rectifier shall be air cooled. Maximum room temperature shall be 104 °F. Cooling air shall be free from corrosion fumes.

B. Materials

1. Enclosure shall be heavy gauge steel with corrosion resistant paint, NEMA 3R.

2. Busbar connections shall be silver plated copper.

3. Busbar connections shall be protected with molded boots. Bare connections or the use of electrical shrink-wrap shall not be permitted.

C. Features

1. The transformer/rectifier maximum dimensions as shown on the Drawings.

2. The transformer/rectifier shall include the following protection features:

a. SCR heat sink over-temperature

b. Transformer winding over-temperature

c. DC current and voltage limit

d. Fan failure detection

e. Door interlock switch

f. Input phase monitor

g. The power supply will automatically shut down in the event of a fault.

3. Output voltage and current shall be monitored by in-built digital voltmeter and ammeter. These instruments shall have accuracy of 1% or better.

4. A built-in potentiometer shall be provided to allow manual current adjustment.

5. The following outputs shall be provided:

a. Rectifier Failure

b. Rectifier Status

c. Rectifier Voltage 4-20mA

d. Rectifier Current 4-20mA

D. Accessories

1. 1,000 MCM Copper Cable, or Equal shall be furnished to connect transformer/rectifier to the hypochlorite generator.

2.6 BRINE AND SODIUM HYPOCHLORITE STORAGE TANK

A. Brine Tank

1. Equipment Tag Number: TK-0310

2. Quantity: One (1)

3. Capacity: 200 gallons

4. The tank shall receive salt by manual fill.

5. The tank shall be configured with a removable, top lid.

6. The tank shall not require additional pipe penetrations for overflow, drainage, venting, and instrumentation.

7. The softened water level in the tank shall be controlled by an automatic, level control float valve on the inlet.

8. Refer to Section 43 40 08 – Polyethylene Tanks.

B. Sodium Hypochlorite Storage Tank

1. Equipment Tag Number: TK-0350

2. Quantity: One (1)

3. Capacity: 750 gallons

4. Refer to Section 43 40 09 – Double-Walled Polyethylene Tanks

C. Provide connections for piping and instrumentation as shown on the Drawings.

2.7 HYDROGEN VENTING BLOWERS

A. Equipment tag numbers:

1. BL-0340

B. Provide blower for the purpose of venting accumulated hydrogen gas from the electrolyzers and sodium hypochlorite storage tanks to the outside as shown on the Drawings.

C. Minimum flow rate: 13 CFM

D. Voltage: 120 VAC

E. Power: ½ HP

F. Controls

1. Provide alarm from FSL-0340 if low flow is detected.

PART 3 -- EXECUTION

3.1 INSTALLATION

A. The sodium hypochlorite generation system shall be installed by the Contractor, in accordance with the OSHG Supplier's printed instructions and recommendations.

B. The Contractor is required to provide and install all interconnecting piping, valving, conduit, wiring, and any other components between equipment provided by the OSHG Supplier that may be required to allow for a complete operating system. The Contractor shall support piping independent of equipment. Equipment shall be free from all loads and stresses induced by the piping.

3.2 SERVICES OF SUPPLIER

A. Factory Testing: The skid shall be factory tested prior to shipment. Prior to testing, the skid shall be connected and operated for at least one (1) hour. At a minimum, the factory test shall include:

1. Pressure test of the electrolyzer casing at 60 psi for a minimum of 30 minutes.

2. Startup sequence verification

3. Sodium hypochlorite concentration verification (0.8% +/- 0.05%)

4. Power consumption verification (kWh AC per lb of chlorine produced)

5. Salt consumption verification (lb of salt per lb of chlorine produced)

6. Alarm simulation and verification

7. Shut down sequence verification

B. Inspection, Startup, and Field Adjustment: An authorized service representative of the Supplier shall visit the Site for minimum two (2) Days to witness the following and to certify in writing that the equipment and controls have been properly installed, adjusted, and readied for operation.

1. Installation of the equipment.

2. Inspection, checking, and adjusting the equipment.

3. Startup and field testing for proper operation.

4. Performing field adjustments to ensure that the equipment installation and operation comply with requirements.

C. Instruction of the Owner's Personnel

1. An authorized training representative of the manufacturer shall visit the Site for minimum of two (2) days to instruct the Owner's personnel in the operation and maintenance of the equipment, including step-by-step troubleshooting with necessary test equipment. Instructions shall be specific to the models of equipment provided.

2. The representative shall have at least two (2) years' experience in training. A resume for the representative shall be submitted.

3. Training shall be scheduled a minimum of three (3) weeks in advance of the first session.

4. Proposed training material and a detailed outline of each lesson shall be submitted for review. Comments shall be incorporated into the material.

5. The training materials shall remain with the trainees.

6. The Owner may videotape the training for later use with the Owner's personnel.

END OF SECTION

SECTION 46 33 50 – PERISTALTIC METERING PUMPS

PART 1 -- GENERAL

1.1 SUMMARY

A. The Contractor shall provide furnish and install positive displacement peristaltic tube pumps, together with all drives, motors, flexible tubes, valves, supports, controls, accessories, and appurtenances necessary for feeding sodium hypochlorite, sodium hydroxide, calcium thiosulfate, and aluminum chlorohydrate, complete and operable, in accordance with the Contract Documents.

B. The requirements of Section 43 21 00 – Pumps, General and Section 46 10 00 - Equipment General Provisions apply to the Work of this Section.

C. The Supplier shall examine the Site conditions, intended application, and operation of the pump system and recommend the pump that will best satisfy the indicated requirements.

D. The peristaltic pump manufacturer shall furnish the pumps, flexible extruded tubing, integrated control panels, self-contained variable speed drive, piping, valves, and all work covered under this section.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 – Submittal Procedures for submittal requirements pertaining to BABA compliance.

B. Reference Specifications

09 96 00	High-Performance Coatings
26 29 23	Variable Frequency Drive Units
40 90 10	Control Strategies
43 21 00	Pumps, General
46 10 00	Equipment General Provisions
46 30 00	Chemical Feed Equipment, General

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures and Section 46 30 00 - Chemical Feeding Equipment, General.

B. In addition to the requirements of Section 01 33 00 – Submittal Procedures, submit the following as one package for each set of identical pumps.

1. Complete details of all peristaltic tube pumps, including pump capacity, discharge pressure, motor power rating, materials of construction, and dimensional information.

2. Complete details, including size, type, materials, and pressure settings for the various pump discharge pressure relief valves.

3. Equipment certifications, tools, written field procedures and calibration graphs shall be provided.

4. Characteristic performance curves showing flow rate as a function of RPM and pressure.

5. Full calibration with default figures performed for a range of pump heads and pump tubing.

6. Operating, maintenance, programming, wiring diagrams and electrical information.

C. Technical Manuals:

1. Technical manuals shall be furnished as specified under Section 01 33 00 – Submittal Procedures and Section 01 73 00 – Installation, Operation, and Maintenance Manuals.

D. Manufacturer’s Certification:

1. The Manufacturer’s Certification shall comply with the requirements of Section 01 33 00 – Submittal Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturer's Experience: The chemical feeding equipment shall be the product of a manufacturer who has designed and manufactured similar equipment and has a record of at least 5 years of successful operation of this type of process. The Contractor may be required to submit evidence to this effect together with a representative list of installations. The pump manufacturer shall maintain a permanent, local service department and a spare parts department.

B. Workmanship and Design: All parts of the equipment shall be amply proportioned for long, continuous, uninterrupted service. Provisions shall be made for easy access for service or replacement of parts.

C. Tube Performance: Tube shall be designed and manufactured for maximum life at specified manufacturer’s operating conditions. Variation in repeatability shall not exceed plus or minus 5 percent over life of hose. Contractor shall submit manufacturer’s test data verifying repeatability of the tube elements.

D. NFS 61 Certification: The tubes and lubricants shall have NSF 61 certification. If NSF 61 certification is not available, then USDA good grade materials shall be used.

E. Pumps shall meet all applicable C ETL US standards per UL610101A.

F. Certification: The Contractor shall obtain written certification from the manufacturer of the peristaltic tube pumps, addressed to the Owner, stating that the equipment will efficiently and thoroughly perform the required functions in accordance with these specifications and as indicated on the drawings, and that the manufacturer accepts joint responsibility with the Contractor for coordination of all equipment, including motors, variable speed drives, controls, and services required for proper installation and operation of the completely assembled and installed unit. The Contractor shall submit all such certificates to the Engineer.

G. Warranty: Contractor shall furnish manufacturer's warranty in accordance with requirements of Section 46 10 00 – Equipment General Provisions. Drive and pumphead warranty shall be for 24 hours continuous duty rated and a minimum of three years from date of shipment and shall cover the drive and pumphead assemblies for manufacturing defects on non-consumable components.

PART 2 -- PRODUCTS

2.1 GENERAL DESCRIPTION

A. Identification

Name	**Tag No.**	**Location**
Sodium Hydroxide Metering Pump No. 1 & 2	P-0510 P-0520	Chemical Building
Sodium Hypochlorite Metering Pump No. 1 & 2	P-0410 P-0420	Chemical Building
Aluminum Chlorohydrate Feed Pump No. 1 to 3	P-0210 P-0220 P-0230	Chemical Building

B. Operating Conditions:

Equipment No.	P-0510 P-0520	P-0410 P-0420	P-0210 P-0220 P-0230
Duty	Intermittent	Continuous	Continuous
Ambient environment	Indoors	Indoors	Indoors
Ambient temperature, degrees F	50 to 80	50 to 80	50 to 80
Fluid service	25% Sodium Hydroxide	0.8% Sodium Hypochlorite	50% Aluminum Chlorohydrate
Fluid temperature, degrees F	45 to 85	45 to 85	45 to 85
Fluid pH range	6-12	6-12	5-9.5
Fluid specific gravity	1.278	1.2	1.34

C. Performance Requirements

Equipment No.	P-0510 P-0520	P-0410 P-0420	P-0210 P-0220 P-0230
Tubing inside diameter (mm)	Per Manufacturer's Recommendation		
Tubing thickness (mm)	Per Manufacturer's Recommendation		
Tubing material	Per Manufacturer's Recommendation		
Maximum Feed dose, gph	0.83	0.6	0.56
Continuous operating pressure (psi)	60	60	60
Motor horsepower	0.5	0.5	0.5
Pump head	Single Head w/ Spring-loaded Track	Single Head w/ Spring-loaded Track	Single Head w/ Spring-loaded Track
Drive type	Variable speed	Variable speed	Variable speed
Power (VAC, Frequency, Phase)	120 VAC, 60 Hz, 1 Phase	120 VAC, 60 Hz, 1 Phase	120 VAC, 60 Hz, 1 Phase
Turndown	50:1	50:1	50:1

2.2 PUMP REQUIREMENTS

A. General:

1. Peristaltic pumping action is created by the compression of the flexible tube between the pumphead rollers and track, inducing forward fluid displacement within the tube by the rotation of the pump rotor and subsequent vacuum-creating restitution of the tube.

2. The pump shall use no check valves or diaphragms and not utilize any dynamic seals in contact with the pumped fluid.

3. The pumped fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.

4. The pump shall be dry self-priming when completely dry with a suction lift capability of up to 30 feet of water and capable of running dry without damaging effects to the pump or tube.

5. The flow through the hose shall be in the direction of the rotor rotation, which shall be reversible.

B. Spring-Loaded Track Pump Head:

1. Pump Head

a. The pump head shall consist of spring-loaded track/ pump head cover with safety interlock, element type tube retainer mechanism, and gear driven roller rotor assembly with integral variable speed drive.

b. A magnetic safety interlock shall render the drive inoperable when the pump cover is opened. When closed, the pump cover shall seal against the pump track for leak containment and controlled waste through the pump head waste port in the event of a tube failure.

c. Pump track construction shall be of aluminum coated with Alocrom pretreatment and exterior grade polyester powder coat. Pump track shall be designed and sized to take specified tubing (tubing for pressures of 40 psi or greater) for optimal occlusion and performance.

2. Pump Tubing:

a. The tubing shall be self-locating when fitted into the pump head. The tube element shall be in contact with the inside diameter of the track and be held in place on the suction and discharge by the element fittings.

b. The pump tubing shall be extruded from Marprene II, a thermoplastic elastomer with a 64 Shore A durometer. Tubing shall have a wall thickness and an ID as indicated above. The tubing shall be equipped with fittings for pump and process lines connections. The tubing elements shall be replaceable with no disassembly of the pump head and require no use of tools. The pump must accept specified tube size.

c. Flexible reinforced transparent PVC hoses shall be supplied by the pump manufacturer for connection of each pump to suction and discharge process lines. The flexible hose shall have all polypropylene fittings required for connection to pump tube element and process lines.

3. Rotor Assembly:

a. The rotor assembly shall be equipped with compression rollers which ensure gradual tube occlusion and compensate for tube size tolerances. Rotor assembly construction shall be aluminum coated with Alocrom pretreatment and exterior grade polyester powder coat with Nylatron Rollers.

b. Rotor assembly shall be equipped with four geared self-lubricating compression rollers driven by a planetary gear reducer. Compression rollers shall be located 90 degree apart for compression of the tube against the track four times per revolution.

c. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent back flow or siphoning.

d. Tube occlusion shall be adjustable by the adjustment of two hex head nuts with springs to set the force with which the cover compresses the tubing. Hex nuts shall be fitted with setscrews to limit compression and shall come factory set to accommodate the specified wall thickness tubing.

e. The rotor assembly shall be mounted on roller bearings to a drive shaft supported between roller bearings mounted in the pump housing. The assembly will engage the drive shaft by means of gear, which shall directly drive each roller independently.

f. The pumping action shall be created by the occlusion (compression) of the pump tube and its subsequent restitution (return to original shape) causing a vacuum effect to draw the fluid into the suction side of the tube. Occlusion shall come factory set to provide an optimal occlusion for each specified wall tubing thickness.

C. Drive

1. Stroking speed shall be controlled automatically by a VFD.

2. VFDs shall be in accordance with Section 26 29 23 – Variable Frequency Drive Units.

3. Each drive shall be a variable speed drive (VSD) rated for continuous 24 hour operation at ambient temperature to 104 degrees F.

4. Drive speed shall have variable speed range as specified in the performance table above.

5. The drive housing shall be painted in accordance with Section 09 96 00.10 – High-Performance Coatings.

6. The motor shall be coupled to the gearbox via direct connection. Pumps with separate base plates and foot-mounted motors are not acceptable.

7. Motors shall be in accordance with Section 26 05 10 – Electric Motors.

8. Pump drive shall be close-coupled and self-aligning, requiring no flexible couplings.

9. Drive enclosure shall be NEMA 4X.

10. Drive speed, pumping direction, run and stop and keypad scaling shall be controlled via a liquid tight membrane keypad mounted on the pump unit or remotely from a SCADA system. Keypad may be deactivated except for stop and start keys to prevent changes from incidental contact.

11. Drive shall have control features to meet functionality requirements for use with the SCADA system and be capable of accepting analog signals ranging between 4-20 mA or 0-10 VDC signals. Signal response may be scaled over any part of the drive speed range. Scaling shall be able to be controlled similarly using a second Analog signal input. Output signal provides feedback of the pump speed shall ranges between 4-20 mA or 0-10 VDC.

12. Other analog features shall be on/off and forward/reverse via dry contact closure or TTL input, TTL output of running/stopped status use of remote potentiometer to control speed, tachometer output shall be selectable as either 0-5 V or 5 V square wave frequency output. On/off contact shall be functional in either manual or analog mode. Manual or analog mode selectable via keypad.

13. Drive control shall have four programmable relay status outputs which can be configured in the pump software for a variety of pump parameters and status.

14. Each drive shall be capable of automatically restarting after power interruption or be configured to require manual restart. Pump shall have non-maintained maximum speed switch for purpose of priming.

15. Drive voltage shall be selectable between 100-120 V 50/60 Hz and 220-240 V 50/60 Hz, 1-phase via 2 position slide type switch which shall be recessed to protect from incidental contact. Power cord shall be standard 120 V type with 3 prong plug and 9 feet in length routed through liquid tight cord clamp. Drive circuitry shall be microprocessor controlled PWM type with closed loop speed control. Drive motor shall be permanent magnet DC with integral gearbox.

D. Hardware: All hardware shall be 316 Stainless Steel.

E. Leak Detector: A leak sensor mounted to the drain port of the pump head shall be supplied by the pump manufacturer for leak detection and pump shutdown in the event of a tubing failure.

F. Mounting and Connections: All base plates and mounting brackets shall be Type 316 stainless steel.

G. Where indicated on Drawings, each pump discharge shall include an isolation ring with pressure switch and gauge. Isolation rings and gauges shall be provided in accordance with the requirements of Section 40 73 00 – Pressure, Strain, and Force Measurement . Pressure switches shall be provided in accordance with the requirements of Section 40 73 00 – Pressure, Strain, and Force Measurement .

2.3 PUMP CONTROLS

A. Pumps shall be controlled in accordance with Section 40 90 10 – Control Strategies, and Section 40 91 00 – Process Control Instrumentation Systems.

2.4 PROTECTIVE COATING

A. Pumps shall be coated in accordance with Section 09 96 00.10 – High-Performance Coatings.

B. Manufacturer standard coating design compatible with chemical fluid applications specified in this Section is acceptable.

2.5 SPARE PARTS

A. The Contractor shall furnish spare parts in accordance with Section 43 21 00 – Pumps, General and Section 01 33 00 –Submittal Procedures.

B. The Contractor shall at a minimum furnish the following spare parts for each pump:

1. Four (4) spare tube elements of the specified size.

2. One (1) spare rotor assembly.

3. One (1) spare pump head assembly.

C. All spare parts shall be packed in containers bearing labels clearly designating contents and pieces of equipment for which intended.

2.6 MANUFACTURER

A. All peristaltic pumps shall be supplied by one manufacturer and manufactured under ISO 9001.

B. Manufacturers, or equal:

1. Watson-Marlow Bredel Inc.

2. Blue-White Industries

3. Prominent

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Pumping equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. General installation requirements shall be in accordance with Section 43 21 00 - Pumps, General and Section 46 10 00 – Equipment General Provisions.

C. Integrated pump control panels shall be tested at the manufacturer's plant prior to delivery to the site of work. All set points shall be programmed. Simulated signals shall be sent to LCP to test operational and alarm conditions.

3.2 MANUFACTURER'S SERVICES

A. General: A Manufacturer's representative for the equipment specified herein shall be present at the Site for the minimum time specified below, exclusive of travel time, for the manufacturer's services specified herein. Fulfillment of the manufacturer's services may require separate trips.

B. Installation Review:

1. The Manufacturer's representative shall provide installation supervision, inspection, startup, and field adjustment per Section 46 10 00 – Equipment General Provisions.

2. The Manufacturer's representative shall be present on-site during installation for a minimum of one (1) 8-hour day.

3. Prior to startup and testing, the Manufacturer's representative shall be present at the Site for a minimum of one (1) day to inspect the equipment and submit documentation that the equipment has been properly installed, lubricated, and maintained after delivery to the Site. The Manufacturer's representative shall verify that the equipment is in accurate alignment, free from undue stresses from anchoring and connecting piping, and protective devices and alarms are functional. The installation documentation shall be included with the Manufacturer's Certificate submitted in accordance with Section 01 33 00 – Contractor Submittals.

C. Training: Provide Owner staff training per Section 46 10 00 – Equipment General Provisions. Prior to startup and testing, the Manufacturer's representative shall be present at the Site for a minimum of one (1) day to conduct operator training.

D. Startup and Field Testing:

1. Field testing shall be in accordance with Section 46 10 00 – Equipment General Provisions.

2. The Manufacturer's representative shall be present at the Site for a minimum of one (1) day for clean water testing.

3. The following field tests shall be performed:

a. Maximum Flow: The pump speed control shall be adjusted to produce the maximum required flow rate per pump. Perform two consecutive tests. Variation in the flow rate of the two tests shall not exceed specified limits.

b. Minimum Flow: The pump speed control shall be adjusted to produce the minimum required flow rate per pump. Perform two consecutive tests. Variation in the flow rate of the two tests shall not exceed specified limits.

c. Calibration Chart: A calibration chart shall be created by graphing pump setting versus capacity between 0% and 100% at 25% intervals for each pump.

d. Variable Speed Motor Test: Motor speed shall be varied from maximum speed to minimum speed while pumping against maximum required discharge pressure. Motors shall not cause drive overload during 10 minutes of operation at minimum speed.

END OF SECTION

SECTION 46 41 14 - IN-LINE MIXING

PART 1 -- GENERAL

1.1 THE SUMMARY

A. The CONTRACTOR shall provide in-line mixers and appurtenances, complete and operable, in accordance with the Contract Documents.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

AWWA C207 Steel Pipe Flanges for Water Works Service - Sizes 4 In Through 144 In.

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures.

B. Shop Drawings

1. Manufacturer's product information demonstrating compliance with this Section.

2. Calculations and data for energy input to fluid.

3. Certification of the proper materials selection.

4. Certificates of NSF-61 Certification

PART 2 -- PRODUCTS

2.1 GENERAL

A. The in-line static (or motionless) mixer shall consist of a static mixing element inserted into a pipe and designed in such a way, as to produce a high degree of turbulent flow.

2.2 IN-LINE STATIC (MOTIONLESS) MIXERS

A. Type: NSF-61 Certified Wafer Style Static Mixer with integral chemical feed ports similar to Westfall Model 6000 and 2800.

B. Size: match pipeline size.

C. Construction: The mixer shall be monolithically cast or securely bonded into a pipe section with flanged or grooved ends, suitable for an operating pressure of 150 psi. The pipe shall have connections for injection of chemical solutions.

D. Mixing Element: The mixing element shall be of corrosion resistant metal or fiber glass reinforced polyester, or similar material capable of withstanding attack by the chemicals injected.

E. Mounting ring: PVC

F. Mixing plate: 0.9 Beta PVC, Quantity 1

G. Injection ports for model 2800: 1/2-IN, Quantity: 3. Two injection port will normally be used. Cap the spare injection port securely to prevent leakage.

H. Injection ports for model 6000: 1/2-IN, Quantity: 3. Three injection port will normally be used.

I. Gaskets: NSF-61 approved – submit chemical compatibility for selected gasket. 1/8-IN THK, Quantity 2.

J. Identification and Service: The mixers shall satisfy the following conditions:

I.D. No.	Main Pipe Size, inches	Model Used	Chemical Solutions	Flow Range, gpm	Pressure Drop, psi-max)
10-MX-0110	Cement-lined Ductile Iron, 8-IN	Westfall 6000	25% Sodium Hydroxide, 0.8% Sodium Hypochlorite, 50% Aluminum Chlorohydrate	70 - 600	0.2 psi at 600 gpm
20-MX-0140	Polyethylene Pressure pipe, 12-IN	Westfall 2800	25% Sodium Hydroxide, 0.8% Sodium Hypochlorite	70 - 600	2 psi at 600 gpm

K. Manufacturers, or Equal:

1. **Westfall**

2.3 CHEMICAL INJECTION QUILL

A. Type: 1/2-IN CPVC CORP STOP WITH PVC SOLUTION TUBE, Retractable, similar to SAF-T-FLO EB-130 including safety chain, compression fitting, and corporation stop.

B. Size: 1/2-IN Valve x 3/8-IN Solution Tube

C. Inlet Connection Size: 1/2-IN

D. Integrated spring loaded ball check valve

E. Ball isolation valve

F. Orientation: All injections quills must be on the same side, within 180 degrees of each other.

G. Pressure rating: 150 PSI

H. Valve material: Stainless Steel

I. Tube Material: CPVC

J. Insertion length: 1/3 of pipe diameter

K. Tip: 45-degree bevel

L. Provide with Flexible Hose Assembly similar to SAF-T-FLO FHA with clear braided PVC reinforced vinyl hose, true union ball valve inlet. Coordinate connection details with in-line mixer manufacturer

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Equipment shall be installed in accordance with the Shop Drawings and as indicated.

B. The manufacturer shall provide installation, operation, and maintenance instructions.

END OF SECTION

SECTION 46 43 10 – FRP FLOATING DECANTERS

PART 1 -- GENERAL

1.1 REQUIREMENT

A. Provide a two FRP Floating Decanters, complete with guide device, retrieval cable, decant hose, for installation in the washwater holding basins.

B. Decanter operates when submersible decant pumps connected to the decant hose operate.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Design, and fabricate FRP Floating Decanter and materials in accordance with manufacturer's recommended procedures and the following codes and standards:

1. ASTM A193 – Stainless Steel Anchor Bolts
2. ASTM D256 – Izod Impact Strength
3. ASTM D570 – Water Absorption Rate
4. ASTM D638 – Tensile Strength
5. ASTM D695 – Compressive Properties of Rigid Plastic
6. ASTM D696 – Coefficient of Linear Expansion
7. ASTM D790 – Flexural Properties
8. ASTM D792 – Density and Specific Gravity at 23°C
9. ASTM D2563-0 – Visual Defects
10. ASTM D2583 – Indentation Hardness
11. ASTM D2584 – Resin, Glass & Filler Content

B. Composition of the FRP Floating Decanter laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI), and the Material Technology Institute (MTI) of the Chemical Process Industry for "Hand Lay-UP Laminates," and shall meet the specifications for Type I, Grade 10 laminates shown in Appendix M-1 of said report.

C. Manufacturer shall be experienced in the design and manufacture of specific FRP floating decanter and accessories for a minimum period of 20 years.

1.3 SUBMITTALS

A. Submit the following for acceptance:

1. Drawings

a. Showing all critical dimensions

b. Showing principal parts and materials

2. Spare parts list and special tools list

PART 2 -- PRODUCTS

2.1 GENERAL

A. Operating Conditions

1. Fluid temperatures between 32°F and 100°F.

2. Outdoor installation, exposure to UV

3. Peak overflow rate not less than 400 gpm

B. Requirements

1. 6" diameter orifice

2. Adjustable baffle tube to exclude floating materials

3. Intake cone with 6" diameter pipe stub

4. 6" diameter flexible hose 20' long with stainless steel clamps

5. T-316 stainless steel rings for tether cable

6. T-316 stainless steel guide and lift assembly

7. T-316 stainless steel pole guides, approx. 14'-0" high

8. NSF 61 certified 6” diameter vacuum hose rated for -22 ft water head

2.2 MATERIALS

A. Engineered composite fiberglass reinforced plastic (FRP) construction completely encapsulating an internal structure.

B. Molded to create a seamless corrosion barrier impervious to moisture.

2.3 MANUFACTURERS

A. **Plasti-Fab, Inc**

B. Approved equal

2.4 INSPECTION

A. Visual inspection for defects shall be made without the aid of magnification and defects shall be classified as to type and level as shown in Table 1 of ANSI/ASTM D2563-0, approved 1977, (or any subsequent revision).

B. The finished product shall have no cracks, crazing, blisters, chips, exposed glass, exposed cut edges, pits, pinholes, dry spots, fish eyes, burned areas, or entrapped air.

C. Wrinkles and solid blisters are not to exceed 1/8” over the finished surface

D. Structural

1. Maximum vertical deflection under full buoyant or gravity load shall be equal to or less than l /360, where l is defined as the unsupported product length in inches or equivalent.

2. The product shall be designed to accommodate thermally induced expansion and contraction over a temperature range of - 10°F to 100°F (-23°C to 38°C), without exceeding the deflection or strain limitations.

3. Adjustment of the submerged orifice shall be made using easily accessible threaded stainless steel adjusting rod with locking nut. The adjustment rod shall be supported by the FRP guide frame, which the submerged orifice/anti-vortex baffle to be easily adjusted. The orifice overflow elevation shall be infinitely adjustable over the projected range of flow.

E. Surface Conditions

1. All floating decanter shall be flat and level across the span.

2. Warpage throughout the entire floating decanter shall not produce a crown of more than 1/16” (1.6mm) in any direction.

2.5 CONSTRUCTION

A. Floating Decanter Body

1. The Floating Decanter body shall be molded in one piece of reinforced thermoset plastic construction for superior structural stability.

2. The resin and gelcoat shall be UV inhibited

3. The exterior surfaces shall be finished with a premium grade gelcoat for superior protection against weathering and discoloration.

4. The surface shall be resin rich to a depth of .010 inches to .020 inches (.25 - .51mm) and reinforced with C-glass and/or polymeric fiber surfacing material.

5. The surface shall be free of exposed reinforcing fibers.

6. The composition of these layers shall be approximately 95% (by weight) resin. The remaining laminate shall be made up of copolymer composite and reinforcing fibers in a form, orientation and position to meet the mechanical requirements.

7. When necessary to cut the laminate structures, drill holes, machine slots, and so forth, all cut edges shall be sanded smooth and sealed with resin solution, paraffinated to prevent air inhibition to ensure the complete sealing of edges to prevent water from penetrating or wicking into the laminate.

8. The exterior surface finish shall be smooth to allow easy access for cleaning and maintenance. Exposed metal exterior ribs will not be acceptable.

9. Decanter shall have a built-in baffle to eliminate surface solids.

10. Decanter shall have no electrical or pneumatic components and no mechanical components in contact with fluid.

11. 6” (102mm / 152mm) flexible corrugated hose with stainless steel clamps shall be supplied for each floating weir/decanter.

12. Metal reinforcing members, where required, shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated with a minimum of 1/8-in. (3-mm) thick laminate to ensure against pinhole bleeding and subsequent rust streaking. Additional protection of the metal reinforcement (galvanizing or the application of rust inhibitive primer) does not preclude the need to completely encapsulate the reinforcing member.

13. Anchoring

    a. Two mooring stabilizers consisting of a stainless steel pipe and a stainless steel flange to be mounted to basin wall or floor.

14. Horizontal movement shall be restricted by tethering cables.

2.6 Physical properties

A. Structural characteristics for a 1/8” (3mm) glass mat laminate shall meet the following minimum physical properties:

TABLE 11551-2

Tensile Strength	15,000 psi (1034 ksc)
Flexural Modulus	1,000,000 psi (70307 ksc)
Flexural Strength	20,000 psi (1406 ksc)
Compressive Strength	22,000 psi (1547 ksc)
Impact Strength	9.0 ft-lbs/in
Water absorption	0.12% (in 24 hours)

B. Extruded virgin neoprene seals shall have the following physical characteristics:

TABLE 11551-3

Specific Gravity	1.25
Hardness	55 – 65 Shore A Durometer
Tensile Strength	1500 psi min. (0.07 ksc)
Elongation	300%
Low temperature brittleness	- 40°

PART 3 -- EXECUTION

3.1 INSTALLATION

A. Thoroughly remove all shipping materials prior to setting in place.

B. Installation may be accomplished by bolting through the bolting flange to an existing structure wall or other suitable flat surface as required.

C. Discharge flow shall be set and verified by hydraulic drop test of each basin.

D. Follow manufacturer’s installation instruction.

END OF SECTION

SECTION 46 53 20 – STORAGE TANK AND PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. The Supplier shall design, and the Contractor shall provide a fiberglass-reinforced plastic water storage tank, pumps and all components, including but not limited to, all pipe penetrations and connections to the tank, buoyancy control, manholes, access hatches, roof vents and their connections to the tank, complete and operable, in accordance with the Contract Drawings and Specifications.

B. All shop drawings and calculations shall be signed and stamped by a Structural or Civil engineer registered in Washington State.

C. Structural shop/fabrication drawings and calculations shall be submitted for review and approval prior to fabrication.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Reference Specifications

01 10 00	Summary of Work
01 33 00	Submittal Procedures
40 91 00	Process Control & Instrumentation Systems
46 10 00	Equipment General Provisions
43 21 00	Pumps, General

B. Commercial Standards:

1. American Concrete Institute (ACI) standard ACI 318, Building Code Requirements for Structural Concrete.

2. ANSI/AWWA D120 – Thermosetting Fiberglass-Reinforced Plastic Tanks.

3. Tank manufacturers shall be recognized as a manufacturer of tanks listed to the ANSI/CAN/UL/ULC 1316:2018 Underwriters Laboratories (UL) Standard for Fiber Reinforced Underground Tanks for Flammable and Combustible Liquids.

4. American Society for Testing and Materials (ASTM) D3299

1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with Section 01 33 00 – Submittal Procedures

B. Shop Drawings and Design Calculations: Shop drawings and design calculations shall include the following:

1. Manufacturer’s qualification submittal

2. Detailed design calculations for the tank including all tank accessories signed and stamped by a registered engineer in the State of Washington and certified by the tank manufacturer.

    a. Calculations shall be provided to prove the tanks meet the loading conditions below

        1) Internal Load – Tank shall be designed to withstand a 5-psig (35 kPa) air-pressure test with a 5:1 safety factor.

        2) Surface Loads – Tank shall be designed to withstand surface H-20 and HS-20 axle loads when properly installed according to manufacturer's current Installation Manual and Operating Guidelines.

        3) External Hydrostatic Pressure – Tank shall be designed for 7 feet (2.1 m) of overburden over the top of the tank, the hole fully flooded, and a safety factor of 5:1 against general buckling.

    b. Calculations shall be provided to prove the tanks are secured from flotation from the conditions characterized in the Geotechnical information provided with the project specifications Appendix A. Contractor shall include the cost of ballast and anchoring in its bid.

3. Dimensioned tank drawings

    a. Location and orientation of openings, fittings, and accessories.

    b. Details of inlet and outlet fittings, manways, flexible connectors, and vents.

4. Quality assurance and inspection program report prior to fabrication.

    a. The report shall include the quality assurance program, including but not limited to the requirement for testing, inspection, names and qualifications of inspectors.

C. Product Data: Submit manufacturer's data sheets on each product to be used, including, but not limited to, the following:

1. Pump product data and information per Section 43 21 00

2. Preparation instructions and recommendations.

3. Bedding and backfill recommendations.

4. Storage and handling requirements and recommendations.

5. Installation manual and operating guidelines.

6. Detailed shipping, handling, and installation instructions.

7. Repair procedures for typical situations, including small holes, pinholes, and minor cracks in the tank.

8. Factory Test Report:

    a. Tank nominal capacity and diameter, material

    b. Review audit for wall thickness

    c. Fitting placement

    d. Visual inspection

    e. Leak testing

    f. Pump test data indicating conformance with head and flow criteria

9. Certification: After inspecting the installed tank, a representative of the manufacturer shall certify in writing that the tank has been installed in accordance with the manufacturer's recommendations. Certification shall be submitted to the Contracting Officer.

10. Special Warranty Requirement

    a. Tank shall be warranted for 3 years to be free of defects in material and workmanship.

    b. Pumps shall be warranted for 1 year to be free of defects in material and workmanship.

1.4 QUALITY ASSURANCE

A. Tank installations in the United States:

1. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of federal, state, provincial and municipal construction, health, safety and environmental codes, and local authorities having jurisdiction.

2. Manufacturer's Qualifications:

    a. The tank manufacturer shall have a record of at least 10 installations during the previous 5 years for the tank sizes indicated in this Contract.

1.5 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with tank manufacturer's Installation and Operating Guidelines recommendations for delivery, storage, and tank handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturer shall have continuous experience in the manufacture of underground FRP tanks for the past 10 years of tanks of similar size required for this project.

B. The tank manufacturer shall provide an installation list (with contact information) of tanks they furnished for a minimum of 10 installations with similar operating conditions

2.2 GENERAL

A. Tank Design – Fiberglass reinforced plastic (FRP) tanks:

1. Tanks shall be manufactured with a laminate consisting of resin and glass fiber reinforcement, single walled, one-piece seamless construction, circular in cross section, horizontal in axis; complete with piping inlets and outlets, drains, and overflows installed by manufacturer.

    a. Double walled tanks will not be accepted. No sand/silica fillers or resin extenders shall be used.

    b. Tank outlets shall be either molded on the tank and be the same material or mechanically attached to a chemical compatible insert encapsulated into the tank wall. Domes and other fittings may be bolted or threaded onto the tank.

    c. Covered tanks shall be vented, and where indicated, tanks shall be provided with access openings. Tanks shall be marked to identify the manufacturer, date of manufacture, serial number, capacity, and use.

2. The tank size, fittings and accessories shall be as shown on the drawings.

3. Dimensions and tolerances shall be in accordance with ASTM D3299. Measurements shall be taken with the tank empty, in the horizontal position.

4. Tanks shall be manufactured with structural ribs which are fabricated as an integral part of the tank wall.

5. Tanks shall be vented to atmospheric pressure.

6. Tanks be capable of handling liquids with specific gravity up to 1.1.

7. Tanks shall be compatible with liquids identified in the manufacturer's standard limited warranty.

B. Water Storage Tank Application:

1. Governing Standards, as applicable:

    a. ANSI/AWWA D120 – Thermosetting Fiberglass-Reinforced Plastic Tanks.

    b. Tank manufacturer shall be recognized as a manufacturer of tanks listed to the ANSI/CAN/UL/ULC 1316:2018 Underwriters Laboratories (UL) Standard for Fiber Reinforced Underground Tanks for Flammable and Combustible Liquids.

C. Tank Design: Single-wall vessel as specified and shown on the Drawings.

D. Deadman Anchoring System

1. Provide a deadman anchoring system to prevent flotation of underground storage tanks due to groundwater or flooding conditions.

2. Materials

    a. Deadman anchors shall be constructed of reinforced concrete, minimum compressive strength of 4,000 psi.

3. Each deadman shall be sized to extend the full length of the tank, placed parallel to the tank and outside the tank shadow.

4. Minimum dimensions:

    a. Height: 12 inches

    b. Width: 12 to 18 inches, depending on tank diameter

    c. Reinforcement: #6 rebar, two longitudinal and one transverse per anchor.

5. Placement and Installation

    a. Deadmen shall be placed at the same depth as the tank bottom, with the edge not projecting more than 6 inches under the tank.

    b. Maintain a minimum 12 inches of bedding material between the tank and the deadman.

    c. Deadmen must be installed outside the tank shadow to maximize soil column weight above the anchor.

6. Anchor Straps and Hardware

    a. Use fiberglass-reinforced plastic (FRP) or polyester hold-down straps rated for underground use.

    b. Straps shall be connected to deadmen using stainless steel turnbuckles, stainless steel wire rope, or approved mechanical connectors.

    c. Provide neoprene rubber liners for steel straps to prevent abrasion and ensure electrical isolation.

7. Engineering and Load Requirements

    a. Anchor points must be engineered to resist buoyancy forces of the tank when empty and submerged.

    b. Provide a minimum of two anchor points per deadman, spaced evenly along its length.

    c. Submit calculations verifying the anchoring system meets uplift resistance requirements with a safety factor of 1.2.

E. Tank Accessories

a. Access Openings:

1) Access openings shall have a diameter of 30 inches and 48 inches (726 mm or 1219.2 mm), complete with riser, H-20 rated lid and necessary hardware.

b. Attached Access Risers and Lids:

1) Attached access risers shall be PVC or FRP with flanged openings.

2) Attached access risers shall be 30 inches or 48 inches (726 mm or 1219.2 mm) in diameter. Riser height is dependent on tank installation and shall be field verified by the Contractor upon installation.

3) Access risers shall be attached to access openings during installation utilizing adhesive or FRP bonding kits as supplied by the tank manufacturer.

4) Access lids shall be fiberglass reinforced polyester with a structural foam core to fit 30 inch or 48 inch access risers.

5) Access risers and lids shall be of Orenco manufacture or approved equal.

c. Traffic Rated Riser Covers

1) The tanks that will be installed under parking lots or other locations subjected to traffic loading shall have a separate concrete ring constructed around the 30-inch access riser and a gasketed, vented fiberglass lid to contain an individual, HS-20-rated manhole cover over the riser, as detailed on the drawings.

2) Manufacture or approved equal

a) Morrison Brothers Co. model 418LC

d. Piping and Fittings:

1) Tanks shall be equipped with factory-installed flanged fittings, or pipe stubs. All hardware for fittings shall be stainless steel for buried applications.

2) PVC piping shall at a minimum meet the requirements of ANSI Schedule 80.

3) All flanged nozzles shall be flanged and flat-faced and conform to Class 150 bolting patterns as specified in ANSI/ASME/ B16.5.

4) Carbon steel and stainless-steel NPT fittings shall withstand a minimum of 150 foot-pounds (203 NM) of torque and 1,000 foot-pounds (1356 NM) of bending, both with a 2:1 safety factor.

5) Expansion Joints

a) Piping subject to expansion and contraction shall be provided with sufficient means to compensate for such movement without exertion of undue forces to equipment or structures, accomplished with

expansion loops, bellow-type expansion joints, or sliding-type expansion joints.

b) Expansion joints shall be provided with flanged ends and constructed of stainless steel, Monel, rubber, or other materials best suited for each individual service.

c) Where bellows-type expansion joints are mounted near the suction nozzle of the pump, a stainless-steel internal liner shall be provided to minimize turbulence as the flow passes through the arches of the bellows.

d) Expansion joints for piping connections to polyethylene tanks nozzles shall be provided by the tank manufacturer, selected for fluid service, and sized for up to 4% tank expansion or movement as required by the tank manufacturer. Fastener hardware shall be of Type 316 stainless steel construction.

e) Expansion joints for other plastic tanks shall be constructed of molded PTFE with at least two convolutions and flanged joints. Flanges shall be ductile iron with Type 316 stainless steel bolts and nuts. Flexible connectors shall be Proco Series 442 molded expansion joint, or equal.

e. Pumps

1) All pump motors shall be in accordance with Division 26 specifications.

2) All pumps shall be controlled in accordance with Division 40 specifications and conform with Section 43 21 00.

3) Pumps shall be Orenco: Effluent pumps – PF100511

a) Pumps installed in the Tank shall be 0.5 horsepower, 120 VAC, single phase, 60 Hz, submersible high head effluent pumps.

b) Pumps shall be UL or CSA listed. The pumps shall have a 1/8in (3.2mm) bypass orifice to ensure flow circulation for motor cooling and to prevent air binding. The pumps shall have a floating impeller or floating stack design to protect against up thrust and increase pump life. The pumps' liquid ends must be repairable (by replacing impellers and/or diffusers) for better long-term cost of ownership. The motor must be rated for continuous use and frequent cycling, at least 100 cycles per day. The motor cable must be suitable for Class I, Division 1 and 2 applications.

c) All pumps shall have internal thermal overload protection and internal lightning protection. All pumps shall undergo 3-point (dead head, design flow, design flow + 30%) factory wet testing to confirm performance.

d) Pumps shall be installed at the base of the tank with a stainless-steel chain attached to the pump for lifting.

e) Pumps shall be installed in flow inducer towers. Flow inducer towers shall be of Orenco manufacture or equal to be compatible with the pumps.

(1) Flow inducer towers shall be 102 inches in height. A flat base shall be provided on the flower inducer tower. Raised fiberglass platforms shall be inside the 5-inch diameter Class 125 flow inducer tubes to provide a surface for supporting the pumps.

(a) Support pipes shall be made of Schedule 80 PVC. Float switch brackets and flow inducer tubes shall be made of PVC. Structural plates and the tower base shall be made of fiberglass.

(b) The diameter of the base of the flow inducer tower shall be 15 inches and each tube allowing for flow to exit the tower shall be 5 inches in diameter.

f) Pump discharge assemblies shall be corrosion resistant and constructed in such a manner as to allow for field adjustment during installation.

(1) Discharge assemblies shall be constructed of PVC valves and flexible hosing. All parts shall be solvent welded or threaded and sealed with PTFE paste. Discharge assemblies shall be able to withstand the pressure head of the pump on which it is installed. Discharge assemblies shall be rated for continuous use.

F. Manufacturers, or Equal:

1. Xerxes Tanks: Fiberglass Reinforced Plastic – or equal

a. Capacities as shown in the Drawings

PART 3 - EXECUTION

3.1 TESTING & INSTALLATION

A. Tank shall be tested and installed according to the tank manufacturer's Installation Manual and Operating Guidelines in effect at time of installation.

END OF SECTION

SECTION 46 61 34 – CONTAINERIZED MEMBRANE FILTRATION SYSTEM

PART 1 -- GENERAL

1.01 DESCRIPTION

A. Description of Work:

1. General: The Contractor shall design and provide a containerized membrane filtration system, complete and operable, in accordance with Contract Documents.

2. The product shall meet American Iron and Steel and BABA requirements. Reference Section 01 33 00 – Submittal Procedures for submittal requirements and BABA compliance.

3. The system shall be automated and perform filtration using qualified hollow fiber membrane modules intended to remove particulate matter, Giardia and Cryptosporidium cysts and oocysts. Included with the system should be all hardware, controls, and piping to allow for trouble-free operation of the hollow fiber membranes, with only occasional operator intervention.

4. Provide warranties described in Section 01 74 00 - Membrane System and Module Warranty

5. Provide services as described in Part 3 – Execution.

B. Acceptable SUPPLIERS:

1. SUPPLIER of the automated water hollow fiber membrane filter system shall have at least 10 years of experience supplying separation systems and demonstrate the resources and ability to fully support the mobile system during deployment of the equipment. This includes the ability to offer the following services: Telephone support during normal business hours; Start-up/commissioning assistance – Installation oversight, commissioning, and Operator Training; On-demand process/equipment troubleshooting and repair services; Service Contracts - 24-hour telephone support, Maintenance Contracts (Equipment and CIP procedures), Remote or on-site occasional system status monitoring, Operations contracts, On-site service for equipment/process troubleshooting and repair; Extended warranty coverage

2. The acceptable SUPPLIER shall be currently certified to meet quality standards as defined by International Standards Organization (ISO) standard 9001.

3. The acceptable SUPPLIER shall provide references for similar systems operating in similar applications using hollow fiber filtration modules.

4. Aria Filtra (Trojan Technologies), H2O Innovation, or approved equal.

5. The basis of the design is the Aria Filtra “Aria FAST T96” Containerized Membrane Filtration System. If Contractor selects a different Containerized Mobile Filtration System, Contractor shall provide an alternate design to accommodate the alternate system at no additional cost to Owner. This includes providing any additional equipment or design modifications that the alternate system requires to meet the performance and layout of the basis-of-design system. For example, if an alternate membrane system does not include an integrated filtrate storage tank and filtrate pumps equivalent to those in the Aria Filtra T96 trailer, the Contractor shall design, furnish, and install a suitable filtrate pump station (and any related piping, controls, or structural modifications) at no additional cost to the Owner. The Contractor’s design shall be signed and sealed by engineers of the appropriate disciplines and shall be submitted for review and approval by Owner, Engineer, and Authorities having jurisdiction. Contractor shall assume all risks associated with an alternate design.

C. Definitions

1. Air Scour (AS): Air Scour is a process in which continuous introduction of air to the bottom of the vertically-oriented membrane modules to shake particles loose while simultaneously flowing filtrate through the membrane module from the filtrate side to flush the particles away from the membrane surface. No chemicals shall be added.

2. Backwash / Reverse Filtration (RF): Reverse Filtration is a process in which filtrate is directed through the module from the filtrate side to the feed side of the membrane for the purpose of flushing particles out of the module. System shall have ability to add chemical(s) as required to this process.

3. Container: The structure that houses the containerized membrane system shall be a shipping container or shipping trailer able to be placed by crane or truck, and contain all system components integral to the containerized unit described in this specification.

4. Maintenance Clean / Enhance Flux Maintenance (EFM): Typically involves a short-duration circulation of a chemical solution through the Filter Assembly. This process reduces the trans-membrane pressure (TMP), increases permeability (specific flux,) and inhibits biological growth on the membrane surface.

5. Clean-In-Place (CIP): A multi-step process whereby chemicals are circulated through the membrane system to remove foulants from the membrane fibers. Chemical steps may include solutions that are high pH with oxidants, low pH, or reducing agents. This process chemically removes the membrane foulants that Backwash and Maintenance Clean do not, and is customized to fit the specified feed water characteristics.

6. Crossflow Recirculation / Excess Recirculation (XR): A fraction of the feed flow enters the membrane modules but bypasses the fibers. XR flow leaves the modules, unfiltered, through a separate port in the membrane module housing.

7. Design Conditions: The specified process requirements, the specified feed water characteristics, and the specified operating conditions for the hollow fiber membrane filtration system such as air temperature, humidity, site elevation, and elevation changes between equipment.

8. Feed Flush (FL): Feed Flush is a process in which feed water is directed through the feed side of the module to drain for the purpose of flushing particles out of the module. No chemicals shall be added.

9. Feed Water: Water as it enters the Filter Assembly.

10. Filter Assembly: Shall consist of a feed/strainer system, module rack assembly, and process tanks. Process piping/valves/instruments/controls shall be skid mounted within the mobile system.

11. Filtrate: Water that has passed through the membrane pores from the feed side to the filtered side.

12. GFD: Gallons of Filtrate produced per square Foot [of membrane area] per Day.

13. Hollow Fiber Membrane: An engineered self-supporting non-woven porous media of polymeric material with an outside diameter of 0.2 to 2.0 mm and an absolute pore size of less than 0.2 micron. Absolute pore size is defined as obtaining greater than 6-log removal (99.9999 percent) of particles or microorganisms of a known size.

14. Interconnect Piping: Piping which connects the SUPPLIER furnished mobile system to ancillary equipment/components supplied by Purchaser / Renter. SUPPLIER Process & Instrumentation Diagram (P&ID) shall clearly delineate what piping is considered Interconnect Piping and not in SUPPLIER scope. Specification, design, supply, and installation of the Interconnect Piping shall be the responsibility of the Purchaser / Renter.

15. Instantaneous Flux: The filtrate flowrate of a Filter Assembly measured at any given time that the Filter Assembly is in production divided by the active membrane surface area (feed side) of the Filter Assembly. Instantaneous Flux is expressed as GFD.

16. Integrity Test: A method of verifying the integrity of the module

17. Membrane Module (Element) - A membrane module is a complete unit composed of thousands of hollow fibers enclosed in a housing, feed inlet, and filtrate outlet.

18. Membrane System Recovery: Shall equal the net volume of membrane-filtered water available for disinfection and distribution divided by the total volume of feed water, less the excess recirculation, if used, entering the membrane train(s) from the prefilter system, expressed as a percentage.

19. Module Rack: Shall consist of parallel rows of manifold-connected hollow fiber membrane modules and all associated piping supported by a steel frame.

20. SUPPLIER or SELLER: The entity that shall specify and supply the major hollow fiber membrane filter system components in accordance with this specification.

21. Train: A group of membrane modules arranged together and that share common feed and filtrate piping. Modules arranged such that the following are performed on all modules in a Train (Backwash, Clean In Place Chemical washing / Maintenance Clean)

22. Unit: The water production entity of a membrane system. A unit consists of a number of membrane modules that share feed and filtrate valving, and the units can usually be isolated from the rest of the system for testing, cleaning, or repair. Also called racks, trains (in conflict with the above definition), or skids

D. SCOPE OF SUPPLY – Mobile Filtration System

1. The SUPPLIER shall specify and supply all major hollow fiber membrane treatment system sub-assemblies, equipment, and components (see Section 5 for detailed equipment requirements) within the mobile system as specified herein, including:

2. FEED / STRAINER SYSTEM

a. Arranged in two (2) parallel flow trains with associated piping, valves, instruments, and controls. Each train shall have a pneumatically operated flow control valve.

b. Mounted on welded steel support frame.

c. Pumps controlled by Variable Frequency Drives (VFDs). Capable of operating with minimum 0.5 psi suction pressure.

d. Automatic backwashing strainer for pre-filtering.

e. Provisions for Excess Recirculation flow. Operator adjustable up to 3 gpm per membrane module.

f. Capable of providing 1500 GPM (total, maximum) of water to the Module Rack Assemblies

g. Low suction pressure (0.5 psi minimum) pump cutoff instrumentation and controls

3. MODULE RACK ASSEMBLY

a. Arranged in two (2) parallel flow trains with manifolded connections for Feed, Filtrate, Air Scour, and Excess Recirculation. Manifolds shall be constructed of NSF61 certified HDPE material

b. Mounted on welded steel support frame.

c. Factory installed membrane modules and all associated components/hardware for installation.

d. Each flow train shall provide a minimum of 25,000 square feet of membrane area with the entire container providing a minimum of 50,000 square feet of membrane area.

4. REVERSE FILTRATION (RF) SYSTEM

a. Capable of providing up to 500 GPM of water to the Module Rack Assembly

b. Pumps controlled by Variable Frequency Drives (VFDs)

c. Mounted on welded steel support frame.

d. Associated piping, valves, instruments, and controls

5. COMPRESSED AIR SYSTEM

a. Air compressor capable of 200 psig discharge pressure.

b. Air quality entering air receiver must meet or exceed ISO 8573-1 Class 1.5.1 (dirt: 0.1 µ and 1 mg/m3, water: 3˚C - 7˚C pdp, oil: 0.01 mg/m3) and be less than 40˚C (104˚F)

c. Associated filters, piping, valves, instruments, and controls

6. CLEAN-IN-PLACE (CIP) / ENHANCED FLUX MAINTENANCE (EFM) SYSTEM

a. Hot Water tank constructed from HDPE material.

b. Chemically resistant immersion heater

c. Pneumatically operated chemical transfer pumps

d. Associated piping, valves, instruments, and controls

7. FILTRATE FORWARDING SYSTEM

a. 1,700 gallon (minimum) filtrate storage tank with level indicating transmitter

b. Two (2) vertical, multi-stage, centrifugal type filtrate pump(s) acting in parallel with common outlet

c. Capable of providing up to 1,400 GPM of filtrate

d. Mounted on welded steel support frame

e. Associated piping, valves, instruments, and controls

8. ANCILLARY EQUIPMENT

a. Valves POV-0110 and POV-0111 shown on drawing 20I-601. External valves required to divert chemical waste from AS / RF drain waste. Connect with ¼-inch air tubing back to solenoid bank. Support valve properly in piping.

b. Valve POV-0112 shown on drawing 20I-601. Requires installation between two flanges in the filtrate piping. Connect with ¼-inch air tubing back to solenoid bank within the trailer. Support valve properly in piping.

9. PLC BASED CONTROL SYSTEM

a. One PLC system with distributed I/O, including software

b. Operator interface is a PC based system running a SCADA software. Communication between SCADA with the PLC shall be Ethernet using the Ethernet/IP communication protocol.

1) Section 40 95 10 - PLC-Based Control System Hardware

10. NEUTRALIZATION SKID AND TANK

a. Provide neutralization tank shown on drawing 30I-601.

b. The neutralization tank shall be a horizontally mounted, white translucent HDPE or FRP tank of minimum 5,000 gallons to contain the chemical waste from any chemically enhanced backwashes, maintenance cleans, or clean-in-place cycles, with sufficient volume to capture and neutralize all chemical waste. The tank shall be supplied with inlet, outlet, and overflow connections. Tank shall have level transmitter and drain connections.

c. Provide neutralization pump skid shown on drawing 30I-601. One neutralization system shall be provided that is sufficiently sized for neutralization of chemicals used in the maintenance clean and clean-in-place processes. The neutralization system shall be located inside the chemical building.

d. Include neutralization pump (120 gpm at 95 feet; 5 HP, 3500 rpm), valves, piping, instruments and transmitter, and valve solenoid bank in skidded arrangement

e. PH and ORP instruments ship loose for field installation. Sensors shall remain wet at all times. Do not install until skid / project is ready for commissioning.

f. Piping connections include compressed air connection to solenoid bank, tank inlet, skid discharge, recirculation discharge, and drain from containerized membrane filtration system.

g. Provide off skid valves POV-1070 and POV-1080 shown on drawing 30I-601 with controls.

E. Coordination

1. The SUPPLIER shall provide engineering and technical support to the Purchaser / Renter related to the membrane equipment, and participate in the commissioning, startup, testing, and training of the personnel in operation of the membrane treatment system as specified herein.

2. Contractor to:

a. Supply and installation of all interconnect piping (raw, potable, residual, etc.) and associated valves/instruments.

b. Installation of mobile system, including but not limited to:

1) Receiving and placement of equipment furnished by SUPPLIER

2) Civil works and housekeeping pads

3) Leveling, alignment, and securing of equipment furnished by SUPPLIER

4) Supply, installation, support, and verification of field wiring and conduit.

F. Reference Specifications

1. Section 01 33 17 - Structural Design, Support and Anchorage
2. Section 01 33 00 - Submittal Procedures
3. Section 01 62 00 - Installation of Membrane Equipment
4. Section 01 66 00 - Commissioning of Membrane Equipment
5. Section 01 67 00 - Acceptance Testing of Membrane Equipment
6. Section 01 73 00 - Installation, Operation and Maintenance Manuals
7. Section 01 73 10 - Training of Operations and Maintenance Personnel
8. Section 01 74 00 - Membrane System and Module Warranty
9. Section 40 05 02 - Piping Identification
10. Section 40 95 10 - PLC-Based Control System Hardware
11. Section 40 95 20 - PLC-Based Control Systems Software

G. Reference Standards and Codes

1. ISO Standard 9001
2. ANSI/NSF Standard 61: Drinking Water System Components – Health Effects
3. NFPA 70 – National Fire Protection Association
4. National Electrical Code (NEC)
5. ISA – The Instrumentation, Systems, and Automation Society
6. NEMA – National Electrical Manufacturers Association
7. IEEE – The Institute of Electrical and Electronics Engineers
8. ASME B&PV Code VIII-1
9. UL 508A
10. Washington Administrative Code (WAC)
11. Water System Design Manual (WSDM), Washington State Department of Health (DOH), DOH Pub 331-123, Revised June 2020.

12. Membrane Filtration Guidance Manual (MFGM), EPA 815-R-009, United States Environmental Protection Agency (EPA) Office of Water, November 2005.

H. SYSTEM DESCRIPTION

1. The mobile filter system shall be composed of two (2) Filter Assemblies working in parallel, along with the Reverse Filtration, Compressed Air, Filtrate, and CIP/EFM systems as applicable. The Filter Assemblies shall independently alternate between producing filtrate and short cleaning phases to remove the particles that collect on the membrane surface during filtrate production.

2. The mobile membrane treatment system shall have the ability to perform the following processes in a fully automated manner:

   a. Pre-filter Backwashing: System shall have the ability to automatically initiate a backwash on feed water strainers based on earliest of differential pressure set-point or elapsed time.

   b. Forward Filtration: The filtration mode shall allow the operator to preset the desired flow rate for clean water production, and the system will automatically adjust the pump speed or flow control valve setting (as applicable) to deliver this rate of water from the system. The system control shall also be configured to vary production rate based on the availability of raw water upstream of the system, or run to maintain a level in a collection clear well downstream of the system. If the system is empty, the system shall perform an automated fill/vent procedure. The SUPPLIER control system shall monitor (via instrumentation and SUPPLIER PLC programming) the entire process and alert OPERATOR to anomalies.

   c. Excess Recirculation: Filter Assembly shall include provisions to permit a percentage of feed flow to enter the membrane module but bypass the fibers. This flow shall leave the membrane module through a separate port and return to the suction side of the feed pump(s).

   d. Flux Maintenance: System shall have the ability to take individual Filter Assemblies off-line to perform a flux maintenance cleaning. System shall initiate flux maintenance based upon flow volume set-point or elapsed time (earliest). Flux maintenance shall include an Air Scour followed by either a Feed Flush or Reverse Filtration, and then returning the Filter Assembly to Filtration mode. The SUPPLIER control system shall monitor (via instrumentation and SUPPLIER PLC programming) the entire process and alert OPERATOR to anomalies.

e. Integrity Testing: System shall monitor the filtrate quality to detect a performance change at the system level and provide the ability to identify a questionable module. System shall include an automated air pressure hold test feature for individual Filter Assemblies. Test pressure shall be 25-30 psig. Test interval shall be determined by OPERATOR and SUPPLIER in accordance with applicable regulations. If rate of pressure decay is too high, the control system shall alarm the OPERATOR and take the Filter Assembly offline. Filter Assembly shall be constructed such that individual membrane modules with broken fibers can be determined by applying air to the feed side and visually or acoustically observing air bubbles on the filtrate side. Individual Filter Assemblies shall also monitor turbidity of the filtrate as an indirect method of continuously assessing the membrane integrity by using effluent turbidity as an indicator of system performance. The SUPPLIER control system shall monitor (via instrumentation and SUPPLIER PLC programming) the entire process and alert OPERATOR to anomalies. Membrane integrity test shall be performed in accordance with USEPA's Membrane Filtration Guidance Manual (2005).

1) SELLER shall program a high filtrate turbidity alarm with a setpoint of 0.05 NTU, to notify operators and remove the membrane rack from service, if exceeded for more than 15 minutes. A successful PDT will be required to place the membrane rack back into service.

f. Compressed Air Supply: System shall provide both high pressure (90 psig) and low pressure (30 psig) continuously on-demand. System shall have the ability to measure and control the air flow used in the Flux Maintenance mode. Air system shall be sized for worst case usage rate. The SUPPLIER control system shall monitor (via instrumentation and SUPPLIER PLC programming) the entire process and alert OPERATOR to anomalies

g. Enhanced Flux Maintenance (EFM): System shall have the ability to take individual Filter Assemblies off-line to perform an Enhanced Flux Maintenance (EFM) cleaning. EFM process shall circulate a chlorine (or other chemical) solution through the Filter Assembly, then rinse. This process reduces the trans-membrane pressure (TMP) and inhibits biological growth on the membrane surface, resulting in a significant extension of the interval between Clean-In-Place (CIP) events. The SUPPLIER control system shall prompt the OPERATOR, monitor (via instrumentation and SUPPLIER PLC programming) the entire process, and alert OPERATOR to anomalies

3. The membrane treatment system shall have the ability to perform the following processes in a semi- automated manner:

a. Clean-In-Place (CIP): System shall have the ability to take individual Filter Assemblies off-line to perform a thorough Clean-In-Place (CIP). The CIP mode shall circulate multiple chemical solutions (with intermediate rinses) through the Filter Assemblies. This process chemically removes membrane foulants that Reverse Filtration and EFM cannot. System equipment and controls shall allow for varying chemical solutions/concentrations to be implemented, based on SUPPLIER specifying an appropriate cleaning regimen to maintain the performance and longevity of the membrane modules. The SUPPLIER control system shall prompt the OPERATOR, monitor (via instrumentation and SUPPLIER PLC programming) the entire process, and alert OPERATOR to anomalies.

b. Chemical Transfer: System shall have the ability to automatically transfer chemicals to the RF, EFM and/or CIP, and/or Neutralization processes. The SUPPLIER control system shall prompt the OPERATOR, monitor (via instrumentation) the entire process, and alert OPERATOR to anomalies.

1.02 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. This project is subject to the Build America, Buy America (BABA) provisions under the Infrastructure Investment and Jobs Act (IIJA). See Section 01 33 00 for submittal requirements pertaining to BABA compliance.

1.03 SUBMITTALS

A. Shop Drawings

1. Coordination Meetings

a. Within fourteen 14 days after execution of the Agreement, the SELLER shall meet with the Engineer at the Engineer's location to address any issues related to the project. The SELLER shall prepare and submit a project specific process and instrumentation diagram (P&ID) of the proposed containerized membrane systems, and neutralization system for discussion.

2. Drawings and Samples:

a. The SELLER shall submit for review and approval in accordance with the Shop Drawing Procedures the following First Shop Drawing Submittals in accordance with Section 01 33 00 - Submittal Procedures. All drawings shall be submitted electronically in pdf format. Electronic drawings shall also be submitted in 3-D format compatible with the Revit design model. The SELLER shall submit the following information:

1) Schematics Drawings:

a) P&IDs of the System, including hydraulic and pneumatic schematics detailing the equipment supplied by the SELLER and showing equipment provided by others that will interface with the System.

b) The Engineer, Buyer and SELLER are responsible for establishing the P&ID tag numbering for the units and the system. The identification and tag numbering shall be in accordance with Section 40 05 02 - Piping Identification and Contract Drawings.

c) Electrical schematic diagrams including motor horsepower and other electrical load information and identification of external wiring (panel) connections and for coordination with the Contractor.

2) Containerized System Drawings: The SELLER shall coordinate production and submit each of the following Arrangement drawings for approval:

a) Provide plan and elevation views of containerized membrane system and all equipment to be included in container.

b) Clearly identify the termination points and physical location for hydraulic, pneumatic and electrical connections where interfacing of the SELLER supplied equipment and equipment to be installed by the Contractor exists

c) Once submitted and approved the “physical envelope” of the SELLER supplied equipment or termination points shall not change without approval of the Engineer

d) A bill of materials for all tagged devices and components supplied with the Unit including component original part numbers identifying each furnished component

3) Neutralization System Drawings: The SELLER shall coordinate production and submit each of the following Arrangement drawings for approval:

a) Provide plan and elevation views of skid mounted neutralization system. The neutralization tank does not need to be mounted on the skid, it will be shipped loose for installation.

b) Clearly identify the termination points and physical location for hydraulic, pneumatic and electrical connections where interfacing of the SELLER supplied equipment and equipment to be installed by the Contractor exists

c) Once submitted and approved the “physical envelope” of the SELLER supplied equipment or termination points shall not change without approval of the Engineer

d) A bill of materials for all tagged devices and components supplied with the Unit including component original part numbers identifying each furnished component

4) The SELLER shall attend a meeting with the Buyer within 10 days after the submittal of the first shop drawing for coordination and review.

b. The SELLER shall submit for review and approval in accordance with Section 01 33 00 - Submittal Procedures.

1) Containerized membrane system:

   a) A bill of materials for all tagged devices and components supplied with the containerized membrane system including component original part numbers identifying each furnished component. For all tagged devices supplied, the SELLER shall develop a “Cross Reference Schedule” that matches the Tag to the appropriate equipment manual. The equipment schedule shall include the pertinent information associated with the equipment including tag number, description, functional name location, component equipment model, part number, size, materials, accessories and range. The Cross-Reference Schedule shall be provided in the form of a Microsoft Excel (.XLS) spreadsheet.

2) Design Calculation:

   a) Design calculations related to sizing of key components, including the overall System, pumps, valves, Units, process air system, backwash system, CIP system, chemical transfer pumps, CIP pumps, and electrical controls and instrumentation supplied by the SELLER Calculations for the piping system shall be sufficient to demonstrate that the system is hydraulically stable (balanced) under normal and backwash operation within the SELLER’s and/or good engineering practice limits. Submittals for pump(s) and throttling and modulating valve(s) shall also include calculations to show that cavitation does not occur over the intended minimum and maximum operating range.

   b) Other submittals and/or shop drawings as required under the Contract Documents

   c) Submit data as required by the applicable components of Section 46 10 00, Equipment General Provisions.

   d) LRV calculation based on the proposed excess recirculation rate. The system volume (Vsys) must be calculated for this specific installation. A site-specific upper control limit based on the design parameters and water quality of this source should be proposed and will be approved by the Engineer which complies with Washington DOH guidelines. Comply with referenced Water System Design Manual and Membrane Filtration Guidance Manual. Plan on three revisions and three virtual meetings to develop this and achieve approval from Washington DOH.

3) Information as specifically requested by the Engineer or Buyer in support of this Project.

4) The SELLER shall attend a meeting with the Buyer within 10 days after the submittal of the second shop drawing for coordination and review.

B. Factory Test Reports

   1. Quality Control Reports

a. Factory Test and SELLER Quality Control Reports for all equipment provided including the Factory Test Report for the PLC/HMI system functional performance test reports

b. Factory Test Reports for all Control Panels

c. Factory Test Report for containerized system

C. Installation Instructions: Refer to Section 01 62 00 - Installation of Membrane Equipment.

D. Commissioning Plan: Refer to Section 01 66 00 - Commissioning of Membrane Equipment.

E. Operation and Maintenance Manuals: Refer to Section 01 73 00 - Installation, Operation and Maintenance Manuals.

F. Training Manuals: Refer to Section 01 73 10 - Training of Operations and Maintenance Personnel.

G. Record Drawings: In accordance with Section 01 73 00 - Installation, Operation and Maintenance Manuals, after completion of Acceptance Testing the SELLER shall revise and submit to the Buyer revised O&M Manuals using As Installed information.

H. Certificates, Warranties and Guarantees

1. Refer to Section 01 74 00 - Membrane System and Module Warranty.

2. SELLER “Acceptance of Installation” following equipment installation.

PART 2 -- PRODUCTS

2.01 MEMBRANE MODULES

A. Based on the Owner’s review and prequalification process, the following membrane modules and membrane elements / manufacturers are pre-qualified, no others will be considered:

1. Aria Filtra (ASAHI) UNA-620A Microfiltration Membrane Module

2. Toray HFUG2020AN Ultrafiltration Membrane Module

B. Membrane modules shall be of hollow fiber construction and configured for a normal filtration flow direction from outside the fiber through to the inside (lumen) of the fiber. They shall be 0.1 micron rated, homogenous, high-crystalline PVDF (Polyvinylidenefluoride) that support high and stable flux rates and constructed with advanced bonding techniques for an exceptionally strong module design. Filtrate shall be allowed to exit the module through only one end of the lumen.

C. Hollow fiber membrane provided shall have demonstrated at least 6.0-log10 reduction of Cryptosporidium oocysts in direct challenge testing by a third party agency.

D. The equipment provided shall be capable of achieving filtrate turbidity values of 0.1 Nephelometric Turbidity Units (NTU) or less at the specified maximum flow rate under normal circumstances.

E. Membrane Hollow fibers manufactured by a Non-Solvent Induced Phase Separation (NIPS) process or by a hybrid process (NIPS and TIPS) shall not be considered.

F. The membrane structure must be of a homogeneous network type, ensuring a uniform pore structure throughout. Spherulite or point contact structure, and asymmetric or composite structure will not be considered.

G. The membrane must demonstrate no discoloration when subjected to an accelerated chemical immersion test in 5000ppm NaOCl+ 2% NaOH for 168 hr. (A brown color in this test is indicative of broken polymer bonds and results in a degradation of the physical properties of the membrane.)

H. The membrane fibers shall be encased in an ABS (Acrylonitrile-Butadiene-Styrene copolymer) housing that is suitable for operating pressures up to 60 psig and up to 104F. The membrane fibers together with the housing shall be referred to as a membrane module.

I. The modules shall be constructed as an integral unit, without mechanical seals such as O-rings and gaskets, to eliminate the risk of raw water bypass to the filtrate side of the membrane.

J. The modules shall not require special lifting mechanisms for handling and must be able to be individually removed from the membrane rack.

K. Membranes and module shall be compatible with the following cleaning and treatment chemicals at the levels indicated:

1.	NaOCl	< 5,000 ppm
2.	NaOH	< 4%
3.	HNO_3, HCl, H_2SO_4	< 10%
4.	Citric Acid	< 10%
5.	Oxalic Acid	< 2%
6.	EDTA	< 0.4%
7.	Hydrogen Peroxide	< 2%
8.	$Na/KMnO_4$	< 5,000 ppm
9.	Chlorine Dioxide	< 0.2 ppm (5 yr), < 0.1 ppm (10 yr)

L. Membrane and module shall be compatible with the following coagulants:

1. Alum (Aluminum Sulfate)

2. PACl (Polyaluminum Chloride)

3. ACH (Aluminum Chlorohydrate)

4. $FeCl_3$ (Ferric Chloride)

5. $Fe_2(SO_4)_3$ (Ferric Sulfate)

2.02 TRAILERS

A. Mobile filtration system shall be installed in a trailer with the following requirements:

1. Licensed/registered, capable of being transported by a standard 'semi type' tractor

2. Adjustable wheel locations

3. Installed HVAC system with 5 ton capacity (minimum) for control of internal ambient temperature. Insulated walls and ceiling.

4. Side egress door with portable stairways for access. Door hinges are to be located on the rear side of trailer door opening.

5. Interior lighting

6. Externally mounted enclosure for chemical pumps

2.03 VALVES

A. Process Valves (2" NPS and larger) – Manually Operated

1. Shall be butterfly type with ANSI B16.5 150# bolt pattern, epoxy coated, cast or ductile iron body, stainless steel disc, EPDM seat, Lug style (Wafer style for < 2 inch) and have NSF 61 Drinking Water Certification.

2. Shall have a dead-end shutoff differential pressure rating equal to or greater than 50 psig (with flanges installed on each valve face).

3. Manual valve operator shall be lever handle or gear operator, based on manufacturer's standard recommendation.

B. Process Valves (2" NPS and larger) – Pneumatically Operated

1. Shall be butterfly type with ANSI B16.5 150# bolt pattern, epoxy coated, cast or ductile iron body, stainless steel disc, EPDM seat, Lug style (Wafer style for < 2 inch) and have NSF 61 Drinking Water Certification.

2. Shall have a dead-end shutoff differential pressure rating equal to or greater than 50 psig (with flanges installed on each valve face)

3. Actuator shall be pneumatic, rack & pinion actuator (double acting or spring-return) with permanently lubricated bearings/guides and mounted to valve body. Pneumatic tubing shall be routed to a solenoid valve manifold.

4. Air supply to pneumatic actuator shall be from a manifold mounted solenoid valve with integral speed control. Pneumatic actuators shall be sized for service air pressure of 80 psig. Plastic tubing shall be used to supply air to actuators.

5. Valve positioners (if applicable) shall be electro-pneumatic type, integrally mounted to valve assembly. Valve positioners shall have a digital 'valve closed' signal and pressure gauges for each inlet port. Air consumption shall be less than 0.001 scfm when positioner is not operating the valve.

6. Actuated valve assemblies shall be designed for one million (1,000,000) cycles.

C. Ball Valves

1. Ball valves for air service shall have stainless steel body and ball, with PTFE seat.

2. Ball valves for fluid service shall be true union type with PVC body and ball. When required, actuators shall be pneumatic.

2.04 INSTRUMENTS

A. Analytic (PH/ORP)

1. PH/ORP sensors shall have a range of 0 to 14 (pH) and -1500 to 1500 mV (ORP).

2. PH/ORP sensors shall have a detachable probe for servicing.

3. PH/ORP transmitter shall have a local LCD display and 4-20mA output signal.

B. Turbidity Sensors/Transmitters

1. Turbidity sensors for individual filter effluent shall be HACH TU5400sc Ultra-High Precision Low Range Laser Turbidimeter with Flow Sensor and Automatic Cleaning Module.

2. Turbidity sensors shall have a sample flow less than 1000 ml/min.

3. Turbidity transmitter HACH SC4500 shall have a local LCD display and 4-20mA output signal.

C. Flow Sensors/Transmitters – Filtrate

1. Flow sensors shall be magnetic flowmeter type and be a wafer body (8" NPS and smaller) to install between ANSI B16.5 150# flanges.

2. Flow sensors 8" NPS and larger shall have a PTFE liner and two (2) electrodes and grounding rings of appropriate material. Flow sensors 6" NPS and smaller shall have a PTFE liner and two (2) measurement electrodes and one (1) reference electrode of appropriate material.

3. Flow sensor shall have NSF 61 Drinking Water Certification.

4. Flow transmitter shall be integrally mounted, 4-20mA (HART protocol), and include both a local operator interface and two (2) discrete signals.

D. Flow Sensors/Transmitters – Excess Recirculation

1. Flow sensors shall paddlewheel insertion type.

2. Flow sensor shall have NSF 61 Drinking Water Certification.

3. Flow transmitter shall have a local LCD display and 4-20 mA output signal.

E. Liquid Level Sensor/Transmitters

1. Level sensor/transmitters shall be pressure type (measuring liquid head in the tank), locally mounted, and have stainless steel construction with silicone fill fluid.

2. Level transmitters shall be 4-20mA, Digital HART protocol, and have a local LCD display.

3. Level transmitters shall have NSF 61 Drinking Water Certification and a factory calibration certificate.

F. Pressure Transmitters

1. Pressure transmitters shall be in-line (locally mounted) with stainless steel construction and silicone fill fluid.

2. Pressure transmitters shall be 4-20mA, Digital HART protocol, and have a local LCD display.

3. Pressure transmitters shall have NSF 61 Drinking Water Certification and a factory calibration certificate.

4. Provide two shelf spare pressure sensors. Shelf spare shall be installed when duty sensor is taken out of service and sent to manufacturer for annual verifications/calibration.

G. Temperature Transmitters

1. Temperature transmitters shall be platinum RTD type and have a head mounted transmitter.

2.05 STRAINERS

A. Feed Water Strainer(s)

1. Feed water strainer shall be fully automatic with integral backwashing features. Waste flow shall be automatically discharged via an actuated valve controlled by the control system. Backwash shall be initiated by differential pressure and/or elapsed time.

2. Strainer body shall be constructed of carbon steel with NSF 61 approved internal liner and appropriate external coating.

3. Strainer screen shall be rated for 300 microns and be stainless steel.

2.06 HEATERS

A. Immersion Heaters

1. Immersion heaters shall be flange mounted (ANSI B16.5 150#) for mounting on vertical tanks.

2. Heaters shall have controls system with integral thermocouple and high limit temperature switch.

3. Heater coils shall have appropriate sheathing material based on tank fluid contents and have sufficient non-heated length to prevent tank wall overheating.

4. Filter system controls shall monitor tank level and keep heater immersed at a minimum level while in operation.

2.07 TANKS

A. Hot Water Tank (CIP/EFM)

1. Tank shall be rectangular, vertically oriented, and have appropriate overflow outlet

2. Tank shall have a steel frame to support tank walls

3. Tank shall be constructed from NSF 61 certified HDPE material and have a manway with cover

4. Tank shall have connection for installing an immersion heater

5. Tank level shall be monitored and controlled by the Control System

B. Filtrate Tank

1. Tank shall be rectangular, vertically oriented, and have appropriate overflow outlet

2. Tank shall have a steel frame to support tank walls

3. Tank shall be constructed from NSF 61 certified HDPE materials and have a manway with cover

4. Tank shall have connections for supplying filtrate to the Reverse Filtration and Filtrate systems

5. Tank level shall be monitored and controlled by the Control System

2.08 COMPRESSED AIR EQUIPMENT

A. Compressors / Receiver

1. Compressor motors shall be TEFC.

2. Compressors shall have the ability to run in Load/No Load capacity control mode.

3. Compressed Air Receiver shall have ASME VIII-1 Code stamp and CRN registration

2.09 SOLENOID VALVE MANIFOLD BANK WITH I/O

A. Solenoid valve manifold (pneumatic valve operation) shall be 2 position 4-way double acting solenoids rated for 24VDC

2.10 PIPE AND PIPE FITTINGS

A. Stainless Steel Piping (Compressed Air only)

1. Stainless steel pipe shall conform to ANSI B36.19 and be ANSI A312 type 304, 304L, 316, or 316L.

B. PVC Piping

1. PVC pipe and fittings shall be NSF 61 approved Type 1 Grade 1 gray with compounds conforming to ASTM D-1784. Pipe and fitting wall thickness shall be Schedule 40 or 80. Socket welded fittings shall be used whenever possible, using solvent bonding techniques (with NSF 61 bonding materials).

2. Flanges shall be equivalent to ANSI B16.5 150#.

C. HDPE Piping

1. All materials of construction that will come in contact with the process fluids media shall be certified in conformance to ANSI / NSF-61.

2. Flanges shall be equivalent to ANSI B16.5 150#.

2.11 SUPPORT STEEL FRAMES

A. Internal to Trailer

1. Frames and/or supports internal to the trailer enclosure shall be constructed of carbon steel and be of primarily welded construction. Frames shall be fabricated per AWS D1.1 or CSA W47.1 / W59 (latest editions). Frame materials shall be seal welded to prevent moisture ingress to welded joint or interior of closed structural member. Frames shall be suitably coated for corrosion protection.

B. External to Trailer

1. Frames and/or supports external to the trailer enclosure shall be constructed of stainless steel and be of primarily welded construction. Fabrications shall be per AWS D1.1 or CSA W47.1 / W59 (latest editions). Frame materials shall be seal welded to prevent moisture ingress to welded joint or interior of closed structural member.

2. The Contractor shall coordinate with the membrane system supplier to develop and fully structural and seismic anchoring system to attached the trailer to the concrete piers in accordance with Section 01 33 17 – Structural Design, Support and Anchorage. The Contractor shall submit a plan and calculations for Engineer review. The container anchorage shall be designed in conformance with the latest edition of the International Building Code (IBC) design criteria per Section 01 33 17, Structural Design, Support, and Anchorage, and signed by a Registered Professional Structural Engineer currently licensed in the State of Washington.

2.12 PUMPS

A. Feed Pumps

1. Pumps shall be rated for continuous duty, be driven by individual Variable Frequency Drives (VFDs) and be controlled from the system SUPPLIER PLC

2. Pumps shall be horizontal end suction centrifugal type with stainless steel casings and close-coupled motors. Suction and discharge flanges shall have bolting equivalent to ANSI B16.5 150 lb. bolt pattern.

3. Pumps shall have mechanical seals that do not require auxiliary air or liquid cooling.

4. Pump motors shall be heavy-duty, inverter-duty, TEFC, Class F insulation, with appropriate voltage/phase.

5. Pumps shall have NSF 61 Drinking Water Certification

6. Pressure control valve on pump suction header is not required.

B. RF Pumps

1. Pumps shall be rated for continuous duty, be driven by individual Variable Frequency Drives (VFDs) and be controlled from the system SUPPLIER PLC

2. Pumps shall be horizontal end suction centrifugal type with stainless steel casings and close-coupled motors. Suction and discharge flanges shall have bolting equivalent to ANSI B16.5 150 lb. bolt pattern

3. Pumps shall have mechanical seals that do not require auxiliary air or liquid cooling.

4. Pump motors shall be heavy-duty, inverter-duty, TEFC, Class F insulation, with appropriate voltage/phase.

5. Pumps shall have NSF 61 Drinking Water Certification

C. Filtrate Out Pump(s)

1. Pumps shall be rated for continuous duty, be driven by individual Variable Frequency Drives (VFDs) and be controlled from the system SUPPLIER PLC

2. Pumps shall be vertical, multistage centrifugal type with stainless steel casings and close-coupled motors. Suction and discharge flanges shall have bolting equivalent to ANSI B16.5 150 lb. bolt pattern.

3. Pumps shall have mechanical seals that do not require auxiliary air or liquid cooling.

4. Pump motors shall be close-coupled, heavy-duty, TEFC, Class F insulation, with appropriate voltage/phase.

5. Pumps shall have NSF 61 Drinking Water Certification

2.13 CHEMICAL TRANSFER PUMPS

A. Pumps shall be positive displacement, air-operated, double diaphragm, self-priming type. Pumps shall be shipped loose and located in the Owner's chemical building.

B. Pump wetted housings (water chambers and manifolds) shall be fabricated out of Teflon, PVDF or polypropylene. The non-wetted housings (center section and air valve) shall be fabricated out of polypropylene. Diaphragm material and other elastomers shall be as recommended by the pump manufacturer for the specific chemical service application.

C. The pumps shall utilize compressed air from the compressed air system. The air supply pressure and flowrate to the pump shall be controlled by a manifold mounted solenoid valve, which is controlled by the SUPPLIER control system.

D. Chemical transfer pumps to include:

1. 30-P-0430 0.8% Sodium Hypochlorite Transfer Pump shown on drawing 30I-604

2. 30-P-0530 25% Sodium Hydroxide Transfer Pump shown on drawing 30I-605

3. 30-P-0540 25% Sodium Hydroxide Transfer Pump shown on drawing 30I-605

4. 30-P-0610 50% Citric Acid Transfer Pump shown on drawing 30I-606

5. 30-P-0620 50% Citric Acid Transfer Pump shown on drawing 30I-606

6. 30-P-0710 38% Calcium Thiosulfate Transfer Pump shown on drawing 30I-607

2.14 NEUTRALIZATION TANK AND PUMP SKID

A. Provide neutralization tank shown on drawing 30I-601.

B. The neutralization tank shall be a horizontally mounted, white translucent HDPE or FRP tank of minimum 5,000 gallons to contain the chemical waste from any chemically enhanced backwashes, maintenance cleans, or clean-in-place cycles, with sufficient volume to capture and neutralize all chemical waste. The tank shall be supplied with inlet, outlet, and overflow connections. Tank shall have level transmitter and drain connections.

C. Tank dimensions:

1. Volume: 5,000 gal (minimum)

2. Diameter: 90” (maximum)

3. Length: 202” (maximum)

D. Provide neutralization pump skid shown on drawing 30I-601. One neutralization system shall be provided that is sufficiently sized for neutralization of chemicals used in the maintenance clean and clean-in-place processes. The neutralization system shall be located inside the chemical building.

1. Include neutralization pump (120 gpm at 95 feet; 5 HP, 3500 rpm), valves, piping, instruments and transmitter, and valve solenoid bank in skidded arrangement

2. PH and ORP instruments ship loose for field installation. Sensors shall remain wet at all times. Do not install until skid / project is ready for commissioning.

3. Piping connections include compressed air connection to solenoid bank, tank inlet, skid discharge, recirculation discharge, and drain from containerized membrane filtration system.

4. Provide off skid valves POV-1070 and POV-1080 shown on drawing 30I-601 with controls

5. Materials of construction:

a. Structural frame: carbon steel, painted

b. Bolting: stainless steel

c. Piping: PVC, EPDM, Stainless Steel

2.15 CONTROLS

A. CONTROLS HARDWARE OVERVIEW

1. Filter control system shall be based on a master PLC with integrated I/O. The master PLC shall control all aspects of system operation including VFDs, and other ancillary equipment as specified above and as required to provide a functioning system.

a. A single PLC is required with the system and communications between the master PLC and the solenoid valve manifolds shall be via Ethernet/IP.

b. System shall be controlled over Ethernet/IP by an industrial computer mounted on the main control panel. The most current, appropriate PC hardware shall be provided.

c. Reference specification sections:

1) Section 40 95 10 - PLC-Based Control System Hardware

2) Section 40 95 20 - PLC-Based Control Systems Software

B. PLC and Panel Mounted I/O

1. Requirements

   a. Manufacturer: Allen-Bradley CompactLogix 5069 series

   b. Programming software: Rockwell Automation Studio 5000

   c. Certifications: UL, CSA (or cUL), CE

   d. A minimum of 10% user memory shall be available after completion of programming

   e. Ethernet/IP Communications or provide a protocol converter to communicate with the SUPPLIER control system. The protocol converter shall be programmed by the SUPPLIER.

2. Discrete Input modules

   a. Max inputs per module: 16

   b. Input type: NPN (Sinking)

   c. Voltage: 24VDC

   d. Removable terminal block (Local I/O)

3. Discrete Output modules

   a. Max Outputs per module: 16

   b. Output type: PNP (Sourcing)

   c. Voltage: 24VDC

   d. Removable terminal block (Local I/O)

   e. Ability to hold last state on fault

4. Analog Input modules

   a. Max Inputs per module: 8

   b. Input range: 0-20mA, 4-20mA configurable

   c. Resolution: 15 bit + sign

   d. Open circuit detection

   e. Calibrated accuracy: 0.15% at 25C

   f. Removable terminal block (Local I/O)

5. Analog Output modules

    a. Max Outputs per module: 4

    b. Output range: 0-21mA

    c. Resolution: 15 bit

    d. Open circuit detection

    e. Calibrated accuracy: 0.05% at 25C

    f. Removable terminal block (Local I/O)

C. Distributed On Machine Mounted I/O

1. Requirements

    a. Manufacturer: Numatics or Approved Equal

    b. Ethernet/IP Communications

    c. IP65/ NEMA4

    d. M12 Connection

    e. LED indication and/or local display

D. Networking Hardware

1. Overview

    a. The networking for the filter systems shall utilize Ethernet as the network physical layer, comprising the switches, interface devices and cabling. The protocols used shall be IP (industrial protocol) and TCP/IP (transmission control protocol and internet protocol).

    b. Managed Ethernet switches shall be used to provide the communication path between devices. Each device shall contain an Ethernet communications module to allow connectivity to the network.

    c. A star topology is preferred. A ring topology can be implemented if redundancy is required.

2. Ethernet switch

    a. Managed

    b. Connection ports: RJ45 – quantity determined by application

    c. LED communication indicating light for each port

    d. Auto negotiation

e. Communication rate: 10/100 MBits/s or higher

f. VLAN capability

g. Port mirroring capability

h. IGMP snooping capable

i. 24VDC supply voltage

j. Stratix 5200 series, or approved equal

3. PLC Ethernet module

a. Communication rate: 10/100 MBits/s or higher

b. Connection port: RJ45

c. Status indication via LEDs and/or display

4. On Machine Solenoid Manifold module

a. Communication rate: 10/100 MBits/s

b. Power: 24VDC

c. Power connector: 4 pin MINI

d. Communications connector: 4 pin M12

e. Environmental rating: IP65/NEMA 4

f. LED and/or display for status indication

g. Manufacturer and Model: Numatics or approved equal

E. Operator Interface Hardware

1. Overview

a. The PC based systems shall be capable of providing the graphical interface for operation of the system as well as the ability to log data, provide historical trending and reporting. The PC based operator interface comprises an industrial PC mounted on the main control panel.

2. PC Based Operator Interface

a. Display size: 15” minimum, 1024 x 768 minimum resolution

b. Display type: TFT

c. Touch Screen: Resistive film

d. Processor: Core Duo, 1.2 GHz minimum

e. RAM: 8GB minimum

f. Hard Drive: 128 GB minimum

g. I/O: 10/100 MBits/s Ethernet, 2 x USB 2.0 minimum

h. Operating system: Microsoft Windows® 10

i. Power: 120VAC or 24VDC

j. USB ports: Two (2) minimum

k. Certifications: cUL, CE

F. Miscellaneous Hardware

1. Uninterruptible Power supply

a. An Uninterruptible Power Supply (UPS) shall be supplied to maintain 120VAC power to the PLC and Operator Interface in the event of a short power loss. The UPS size will provide full load for a minimum of 10 minutes at full load.

2.16 SYSTEM DESIGN AND PERFORMANCE REQUIREMENTS

A. Service Conditions

1. Ambient Environment. The equipment furnished under this section will be installed at the locations shown on the Drawings. The site conditions are expected to be as follows:

a. Ambient Air Temperatures: 20°F to 105°F

b. Relative Humidity: 0 to 100 percent noncondensing

c. Altitude: 621.5 feet above Mean Sea Level

d. Environment: Rural area northwest of the City of Carson, annual rainfall approximately 74 inches and winds up to 42 mph.

2. Feedwater Quality from Bear Creek:

a. Turbidity: 100 NTU maximum

b. Total organic carbon: 4 mg/L maximum

c. Raw water temperature: 2.5 deg C to 21.1 deg C

d. ACH coagulant dose: maximum 12 mg/L as product; typical 3 mg/L as product

3. Estimated design elevations:

a. See design drawings

B. Process Design Requirements

a. Minimum Recovery for Membrane System 95%

b. Minimum Chemical In Place Interval: 30 days

c. Minimum maintenance cleaning interval: 24 hrs frequency

d. Filtered Water Quality Requirements:

1) Turbidity

a) Maximum filtered water turbidity (ntu): 0.15

b) Maximum filtered water turbidity 95% of time (ntu): 0.10

2) Microbiological Removal

a) Minimum *Giardia* Removal: >4-log (99.99 percent)

b) Minimum *Cryptosporidium* Removal: >4-log (99.99 percent)

2.17 EQUIPMENT DESIGN AND FABRICATION REQUIREMENTS

A. General System Requirements

1. Cross Connection Control

a. The SELLER shall design the membrane process with cross-connection control to assure that chemical solutions used as part of a Chemical Maintenance Clean or Clean in Place process do not come in contract with raw or filtered water. Meet requirements of DOH WSDM section 10.7.2 item 8 and EPA MFGM Section 7.3.4, whichever is most stringent.

b. Any cleaning process, other than backwashing, must use a cross connection control strategy. Cross connection control shall be automated.

c. The cross-connection control strategy shall segregate the supply of the cleaning solution (chemical maintenance clean or Clean In Place solution) from the backwash solution.

d. The cross-connection control strategy shall isolate the individual membrane unit from the membrane train during the chemical maintenance clean or Clean in Place process. The cleaning solution shall be adequately rinsed from the membrane unit using raw or filtered water. Analytical instrumentation shall be used to confirm that the cleaning solution has been adequately rinsed.

e. The cross-connection control strategy shall be structured and interlocked such that the supply or discharge of cleaning chemicals remain segregated from the backwash.

f. If a common manifold is used for the delivery or discharge of two or more cleaning solutions, the common manifold shall be flushed and drained before a change in chemicals is made.

g. Double block and bleed valve arrangements for cross connection control shall be provided in the following pipelines:

1) CIP Supply & Drain

2) Feed Water

3) Excess Recirculation

4) Filtrate

B. System Design Requirements

1. The P&IDs show the process design intent for the project.

a. The proprietary control is not shown on the drawings and is to be developed by the SELLER in accordance with the Contract Requirements. The SELLER is solely responsible for establishing the control of the MF System and for interfacing with the plant control system.

b. The SELLER shall develop P&IDs and identifying all I/O (analog discrete and digital) at the PLC and HMI levels. PLC and HMI operations shall be provided by the SELLER and include ranges, alarms, set-points, control, primary interlocks and trending functions to describe system operation.

2.18 SPARE PARTS

A. The SELLER shall provide the following critical spare parts:

P&ID tag	Part Description
LIT-1	PRESS TRANS,RSMT,0-30PSI,SS,CSA,CAL,DW
PIT-1A	PRESS TRANS,RSMT,0-150PSI,SS,CSA,CAL,DW
CV-2	VALVE,CHECK,BALL,0.5,SPR,220#,THD,KY/VIT
FE-1A	FLOW SENSOR,6"WAFER,316L/PTFE,RSMT 8711
FE-2A	TURB,HACH,TU5300/TU5400 FLOW SENSOR
FIT-1A	FLOW TRAN,ROSEMOUNT,24VDC,8732E,NO TUBE
FIT-2	FLOW TRANS,IFM EFECTOR,24V,2.0",0-412CFM
FIT-3A	FLOW SENSOR,PADDLEWHEEL,SIGNET 2537
P-9	PUMP,DIAPH,0-15 GPM,WILDEN,P1,PP
PHC-1/PI-1/F-1	ASSY,REGULATOR, 1/2 NPT,2 STAT,FILT,ASCO
PHC-2/PI-2	REG,AIR PRESS,1.5IN,FNPT,40 PSIG,W/GAGE
PSH-1	PRESSURE SWITCH,BARKSDALE,3.90-80PSI

P&ID tag	Part Description
SV-14A	VALVE,SOLEN,.75IN,ASCO8212,120VAC,2WAYNC
TE-1A	TEMP,SENSOR,6"RTD,4-WIRE,ROSEMOUNT 214C
VFD-1A	VFD,DANFOSS,30HP(22KW),460V,3P,N4X,ENET
VFD-2	VFD,DANFOSS,11KW,3X380-480V,ETHERNET
VFD-7A	VFD,DANFOSS,25HP(18KW),460V,3P,N4X,ENET
MODPART	ASSY,HOSE,XR,T96,8IN
MODPART	ASSY,HOSE,XR,LONG,PAMTMF,R2.0
F-2	FILTER,OIL-SEP,DF170,PAMTMF,R2.1
F3	DRYER, AIR, MEMBRANE, 2.28 - 9.55 CFM
Air System	FILTER,AIR,ELEMENT,UNIGY,IR,PAM
Air System	FILTER,ELEMENT,OIL-SEP,DF170,PAMTMF,R2.1
Air System	FILTER,OIL,4IN,ELEMENT,IR,39329602
Air System	KIT,SERVICE,THERMAL VALVE,IR,47518605001
Air System	OIL,ULTRA FOOD GRADE,INGERSOLL RAND,5L
Air System	PRE-FILTER,PAD,R5,5 1,IR,PAM,24286676
Air System	SEPARATOR,ELEMENT,IR,PAM,24121212
Compressor	V-BELT,COMP,IR,PAM,47501875001
ARV-15A	VALVE,RELIEF,1",VAC/AIR BRKR,NPT,NYLON
Seal Kit	SEAL,PUMP,CNTRF,10K65,GOULDS,23SH,SD
Seal Kit	SEAL,PUMP,CNTRF,10K64,GOULDS,5SH/6SH,SD
Seal Kit	KIT,PUMP,SEAL,REBUILD,SSH/ESH,FKM,10K45
Control Panel	FUSE,LITTELFUSE,10AMP,TYPE T,5x20mm
Control Panel	FUSE,LITTELFUSE,1AMP,TYPE T,5x20mm
Control Panel	FUSE,LITTELFUSE,2AMP,TYPE T,5x20mm
Control Panel	FUSE,LITTELFUSE,5AMP,TYPE T,5x20mm
Control Panel	PLC COMP,AB,FLEX I/O,ETHERNET ADAPTER
Control Panel	RELAY,CONTRL,AB,6A,120VAC,SLIMLINE,SPDT
Control Panel	RELAY,CONTROL,AB,6A,24VDC,SLIMLINE,SPDT
N/A	MANIFOLD,NUMATICS,12VALVE,580,ENET,501
Strainer	REPAIR,AMIAD,SAF3000,SPLIT PIN
Strainer	PIN,CONNECT,AMIAD,SAF
Strainer	SEAL,O-RING,TIGHT NUT,24X3,EPDM
Strainer	Slotted pin 3 x 30 (St.St.)
Strainer	Slotted pin 5 x 50 (St.St.)
Strainer	SEAL,O-RING,INTERNAL NUT,14X3,EPDM
V-40	COMP AIR DRAIN,CAD250, 1/2",250PSI,180F
VFD	CARD, CONTROL, MCA 121 ETHERNET
Flow Switch	FLOW SWITCH,IFM EFFECTOR,7.5",ALL

2.19 SPECIAL TOOLS

A. The SELLER shall provide special tools required for disassembly and reassembly or analysis of membrane modules.

B. The SELLER shall provide all lifting assemblies, hooks, straps, cables and accessories for removing the membrane modules from the rack assemblies.

2.20 LUBRICANTS

A. Refer to Section 01 73 00 - Installation, Operation and Maintenance Manuals for Safety Data Sheet submittal requirements.

PART 3 -- EXECUTION

3.01 INSTALLATION

A. Refer to Section 01 62 00 - Installation of Membrane Equipment.

3.02 COMMISSIONING

A. The SELLER is responsible for the complete commissioning of the MF system after the Notice of Completed Installation.

B. Refer to Section 01 66 00 - Commissioning of Membrane Equipment.

3.03 TRAINING

A. Refer to Section 01 73 10 - Training of Operations and Maintenance Personnel.

3.04 ACCEPTANCE TESTING

A. Refer to Section 01 67 00 - Acceptance Testing of Membrane Equipment.

END OF SECTION