SEAL ROCK WATER DISTRICT
SEAL ROCK, OREGON

BID DOCUMENTS

for the construction of the

PHASE IV BEAVER CREEK WATER SUPPLY

Volume 3 of 6
Divisions 31 through 49

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CH2M HILL
Corvallis, Oregon

December 2019

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**Paul Ancil Berg**

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Luke Aaron Scoggins

SIGNED: December 13, 2019

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![Certificate Image]

**Expires 06-30-2022**

Darren James Edwards

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DIVISION 46—WATER AND WASTEWATER EQUIPMENT

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DIVISIONS 47 THROUGH 49—NOT USED
PHASE IV BEAVER CREEK WATER SUPPLY

VOLUME 3A

GEOTECHNICAL DATA REPORT

VOLUME 4

DRAWINGS

VOLUME 5

WESTECH REFERENCE DRAWINGS

VOLUME 6

COMPLETE WESTECH SUBMITTAL DATA

END OF SECTION
PART 1   GENERAL

1.01 DEFINITIONS

   A. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

   B. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface.

   C. Grubbing: Removal of vegetation and other organic matter including stumps, buried logs, and roots greater than 2-inch caliper to a depth of 6 inches below subgrade.

   D. Scalping: Removal of sod without removing more than upper 3 inches of topsoil.

   E. Stripping: Removal of topsoil remaining after applicable scalping is completed.

   F. Project Limits: Areas, as shown or specified, within which Work is to be performed.

1.02 SUBMITTALS

   A. Action Submittals: Drawings clearly showing clearing, grubbing, and stripping limits.

1.03 QUALITY ASSURANCE

   A. Obtain Engineer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

   A. Prepare Site only after adequate erosion and sediment controls are in place. Limit areas exposed uncontrolled to erosion during installation of temporary erosion and sediment controls.
PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Clear, grub, and strip areas actually needed for waste disposal, borrow, or Site improvements within limits shown or specified.

B. Do not injure or deface vegetation that is not designated for removal.

3.02 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
5. Roadways: Clearing, grubbing, scalping, and stripping 30 feet from centerline.
6. Overhead Utilities:
   b. Scalping and Stripping: Wherever grading is required.

B. Remove rubbish, trash, and junk from entire area within Project limits.

3.03 TEMPORARY REMOVAL OF INTERFERING PLANTINGS AT INTAKE SITE

A. Remove and store, as specified in Section 329300, Plants, shrubs and trees that are not designated for removal but do interfere with construction or could be damaged by construction activities.

B. Photograph and document location, orientation, and condition of each plant prior to its removal. Record sufficient information to uniquely identify each plant removed and to assure accurate replacement.

3.04 CLEARING

A. Clear areas within limits shown or specified.

B. Fell trees so that they fall away from facilities and vegetation not designated for removal.
C. Cut stumps not designated for grubbing flush with ground surface.
D. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

3.05 GRUBBING

A. Grub areas within limits shown or specified.

3.06 SCALPING

A. Do not remove sod until after clearing and grubbing is completed and resulting debris is removed.
B. Scalp areas within limits shown or specified.

3.07 STRIPPING

A. Do not remove topsoil until after scalping is completed.
B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.
C. Stockpile strippings, meeting requirements of Section 32 91 13, Soil Preparation, for topsoil, separately from other excavated material.

3.08 MERCHANTABLE TIMBER

A. Trees classified as merchantable timber will be marked by Engineer. Saleable logs will remain property of Owner.
B. Exercise care in cutting and felling to prevent damage to saleable logs. Cut, trim, and handle logs in such manner that will ensure best sale value.
C. Cut logs in increments of 2 feet between minimum length of 8 feet and maximum length of 24 feet, plus 8 inches for trim. Cut limbs off flush with trunks. Saleable logs shall each have a minimum top diameter of 8 inches, and minimum of 50 board feet.
D. Stockpile saleable logs in neat, orderly piles at location shown.
E. Do not dispose of unsaleable wood material over 6 inches in diameter without first offering it free to public for use as firewood.
3.09  TREE REMOVAL OUTSIDE CLEARING LIMITS

A.  Remove Within Project Limits:

1.  Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.

B.  Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.10  PRUNING

A.  Remove branches below the following heights:

1.  20 feet above roadways and shoulders.
2.  9 feet above sidewalks.
3.  6 feet above roofs.

B.  Prune as specified in Section 32 93 00, Plants.

3.11  SALVAGE

A.  Saleable log timber may be sold to Contractor’s benefit. Promptly remove from Project Site.

3.12  DISPOSAL

A.  Clearing and Grubbing Debris:

1.  Dispose of debris offsite.
2.  Burning of debris onsite will not be allowed.
3.  Woody debris may be chipped. Chips may be sold to Contractor’s benefit or used for landscaping onsite as mulch or uniformly mixed with topsoil, provided that resulting mix will be fertile and not support combustion. Maximum dimensions of chipped material used onsite shall be 1/4 inch by 2 inches. Dispose of chips that are unsaleable or unsuitable for landscaping or other uses with unchipped debris.
4.  Limit offsite disposal of clearing and grubbing debris to locations that are approved by federal, state, and local authorities, and that will not be visible from Project.

B.  Scalpings: As specified for clearing and grubbing debris.
C. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil offsite.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN-m/m³)).
   b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and scarification and compaction of subgrade.

C. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

D. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

E. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

F. Prepared Subgrade: Prepared ground surface or layer of existing soil prior to placement of geotextile or fill.

G. Proof-Rolling: Testing of subgrade by compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing; and Section 31 23 16, Excavation, prior to subgrade preparation.
1.04 QUALITY ASSURANCE
   A. Notify Engineer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS
   A. Prepare subgrade when unfrozen and free of ice and snow.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL
   A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
   B. Bring subgrade to proper grade and cross-section and uniformly compact surface.
   C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
   D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION
   A. Under Earthfill or Reinforced Soil Slope Fill: Compact upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557 Method.
   B. Under Pavement Structure, Floor Slabs-on-Grade, or Granular Fill Under Structures: Compact the upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557 Method.

3.03 MOISTURE CONDITIONING
   A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
   B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.
3.04 TESTING

A. In-Place Density Tests: In accordance with ASTM D6938 at a frequency of at least two tests under each separate structure; and one per every 1,000 square feet of subgrade at locations designated by the Engineer.

3.05 CORRECTION

A. Soft or Loose Subgrade:
   1. Adjust moisture content and recompact, or
   2. Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

B. Unsuitable Material: Over excavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation, as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION
PART 1 GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.
   c. Proposed onsite and offsite spoil disposal sites.
   d. Numbers, types, and sizes of equipment proposed to perform excavations.
   e. Anticipated difficulties and proposed resolutions.
   f. Reclamation of onsite spoil disposal areas.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

B. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.
C. Excavation Support: Install and maintain, as specified in Section 31 41 00, Shoring, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Engineer.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

3.02 UNCLASSIFIED EXCAVATION

A. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.

2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.

3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.
3.04 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES
   A. Semicircular, trapezoidal, or 90-degree-V.
   B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.05 EMBANKMENT AND CUT SLOPES
   A. Shape, trim, and finish cut slopes to conform with lines, grades, and cross-sections shown, with proper allowance for topsoil or slope protection, where shown.
   B. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.
   C. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.
   D. At locations where earth-retaining structures are shown on Drawings, adjacent to excavations, construct the required earth-retaining structures prior to beginning the excavations.

3.06 STOCKPILING EXCAVATED MATERIAL
   A. Stockpile excavated material that is suitable for use as fill or backfill onsite in designated staging areas until material is needed.
   B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
   C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.
   D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
   E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.
3.07 DISPOSAL OF Spoil

A. Dispose of excavated materials, which are unsuitable or not needed for fill or backfill, in designated spoil disposal areas.

B. Dispose of debris resulting from removal of underground facilities.

C. Dispose of debris resulting from removal of organic matter, trash, refuse, and junk as specified in Section 31 10 00, Site Clearing, for clearing and grubbing debris.

END OF SECTION
PART 1    GENERAL

1.01 EXISTING CONDITIONS

A. Groundwater levels at the site change due to seasonal variation in precipitation and the stage of Beaver Creek. Groundwater levels near the Intake Structure and Facility are anticipated to closely correlate to the stages of Beaver Creek.

B. Background on groundwater observations at the site is provided in the following:

1. Geotechnical Data Report dated October 2018 prepared by CH2M HILL for summary of creek stage readings from previous studies.

C. Contractor shall make their own determination of expected groundwater conditions and seasonal variability in scheduling work and designing and operating dewatering systems.

1.02 SUBMITTALS

A. Informational Submittals:

1. Water control plan at least 14 days prior to installing dewatering system.
2. Cofferdam plan for intake construction. Include description of cofferdam, of equipment to be used, construction methods, and proposed method of minimizing turbidity impacts.
3. Plan for construction outfall to demonstrate minimum of impacts to creek.

1.03 WATER CONTROL PLAN

A. The Contractor is responsible to assess and own these risks and developing schedule and plan accordingly.

B. As a minimum, include:

1. Descriptions of proposed cofferdam facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, and discharge location to be used.
2. Drawings, as needed, to explain cofferdam plans.
C. If system is modified during installation or operation revise or amend and resubmit Water Control Plan.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. Dewatering to be maintained until all slabs and walls have achieved their 28-day strength, as specified in Section 03 30 00, Cast-in-Place Concrete.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 COFFERDAM SYSTEM FOR INTAKE CONSTRUCTION

A. In-water work is limited to July 1 to September 15. Develop schedule to show completion within this time. If any concerns with completing by September 15, advise Owner and Engineer promptly, but at least by August 31, and there may be an opportunity for an agency-granted extension.

B. Schedule and plan shall minimize the extent and duration of in-water work. Contractor shall mobilize all needed equipment and materials to avoid delays in the work. Include a Fish Passage Plan, in accordance with ODFW requirements.

C. Notify Engineer at least 14 days before cofferdam installation. Engineer will provide fish biologist to observe installation. Contractor shall coordinate work with Engineer and fish biologist to minimize fish take during installation and operation of cofferdam. Fish biologist will capture and relocate trapped fish, in accordance with permit conditions, and Contractor will allow for this effort in Project schedule. Fish biologist will complete and submit Fish Salvage Report and submit to NMFS within 90 days.

D. Prior to beginning intake structure construction, clearly mark with flagging or survey marking paint sensitive areas, access routes, and staging, storage, and stockpile areas. Staging, stockpile, and storage areas shall be selected to
ensure that hazardous materials do not enter creek and drainages. Do not dispose of non-native materials in the functional floodplain. Restore temporarily disturbed areas to original contours and conditions. Minimize damage to natural vegetation and permeable soils.

E. Use dust abatement measures commensurate to site conditions.

F. Provide upstream and downstream warning to boaters (canoes, kayaks, paddle-boards, etc.) of construction activities on creek.

G. Keep construction equipment above Ordinary High Water (OHW) elevation to maximum extent possible. No equipment shall enter the flowing creek. Thoroughly clean all equipment and materials before using close to or below OHW elevation. Equipment shall not be leaking lubricants. Engines or motors used near or below OHW elevation shall use food-grade lubricants.

H. Take precautions to prevent spills or exposures of hazardous materials to creek. Avoid or minimize pollutants discharged to creek.

I. Limit size of cofferdam area to maximum extent possible, and in no case shall it be longer than 50 feet or encompass more than 250 square feet. It may not obstruct more than one-quarter of the active channel width. It shall be sheetpile, AquaDam, plywood and plastic, or similar material, set in streambed.

J. Cofferdam shall include a turbidity curtain to exclude release of turbidity-causing soil and materials into creek. The downstream turbidity increase from construction activities shall be limited as follows:

1. Owner and/or Engineer shall monitor, record, and report turbidity upstream and downstream of construction site at 2-hour intervals during daylight hours, in accordance with agency requirements. These measurements will be used to control work, unless Contractor wishes to supplement Owner/Engineer’s measurements with Contractor’s own monitoring.

2. Pursuant to OAR 340-041-0036, short-term turbidity exceedances beyond an allowable 10 percent increase over background are allowed as follows:
   a. 0 ntu to 4 ntu Above Background: No restrictions.
   b. 5 ntu to 29 ntu Above Background: Work may continue a maximum of 4 hours. If turbidity remains 5 ntu to 29 ntu above background, stop work and modify practices. Work may resume when turbidity drops to 0 ntu to 5 ntu above background.
c. 30 ntu to 49 ntu Above Background: Work may continue a maximum of 2 hours. If turbidity remains 30 ntu to 49 ntu above background, stop work and modify practices. Work may resume when turbidity drops to 0 ntu to 5 ntu above background.

d. 50 ntu or more Above Background: Stop work immediately. Owner/Engineer will notify Oregon DEQ for direction.

K. Treat water from dewatering pump(s) before discharging it to the creek. Treat water using filter sediment bags or vegetated strip.

L. Following construction, return streambank to original contours. Restore any significant disturbance of riparian vegetation soils, streambank, and stream channel. Remove waste. Loosen compacted soil areas.

M. Stockpile excavated streambank material and use for final layer of fill when backfilling around intake structure. Dispose of excess excavated material at an offsite location that is above 100-year floodplain, which is arranged for by Contractor.

3.04 OUTFALL (SUPERNATANT DISCHARGE LINE) CONSTRUCTION

A. In-water work is limited to July 1 to September 15. Develop schedule to show completion within this time. If any concerns with completing by September 15, advise Owner and Engineer promptly, but at least by August 31, and there may be an opportunity for an agency-granted extension.

B. Schedule and plan shall minimize the extent and duration of in-water work. Contractor shall mobilize all needed equipment and materials to avoid delays in the work. Limit time of construction below OHW to 1 day.

C. Keep construction equipment above OHW elevation to maximum extent possible. No equipment shall enter the flowing creek. Thoroughly clean all equipment and materials before using close to or below OHW elevation. Equipment shall not be leaking lubricants. Engines or motors used near or below OHW elevation shall use food-grade lubricants.

D. Take precautions to prevent spills or exposures of hazardous materials to creek. Avoid or minimize pollutants discharged to creek.

E. Following construction, return streambank to original contours. Restore any significant disturbance of riparian vegetation soils, streambank, and stream channel. Remove waste. Loosen compacted soil areas.
3.05 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain water level a minimum of 2 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, and until backfilled to final grade.

B. For the Intake Structure, dewatering system shall include wells or well points, and other equipment and appurtenances installed outside limits of excavations and sufficiently below lowest point of excavation, or to maintain specified groundwater elevation.

C. Design and Operate Dewatering Systems:
   1. To prevent loss of ground as water is removed.
   2. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
   3. To relieve artesian pressures and resultant uplift of excavation bottom.

D. Provide sufficient redundancy to keep excavation free of water in event of component failure.

E. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

F. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.06 MONITORING WELLS

A. Monitoring Groundwater Levels: If monitoring wells are a part of Contractor’s cofferdam and dewatering plan, they shall be installed in accordance with Oregon Administrative Rule 690-240.

B. After groundwater level observation wells, if any are installed, are no longer needed for monitoring groundwater levels, abandon observation wells, as required by regulations.

3.07 SETTLEMENT

A. Monitoring Dewatering-Induced Settlement: Establish monuments for monitoring settlement at locations shown on Drawings. Monitor vertical movement of each settlement monument, relative to remote benchmark selected by Engineer, at frequency stated in Contractor’s Dewatering Plan.
3.08 MONITORING FLOWS

A. Monitor volume of water pumped per calendar day from excavations, as Work progresses. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Engineer.

3.09 DISPOSAL OF WATER

A. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge. Treat water using filter sediment bags or vegetated strip.

B. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

C. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.10 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

END OF SECTION
SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   d. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
   f. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).


1.02 DEFINITIONS

A. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

B. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.
C. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

D. Completed Course: A course or layer that is ready for next layer or next phase of Work.

E. Lift: Loose (uncompacted) layer of material.

F. Geosynthetics: Geotextiles or geogrids.

G. Well-Graded:
   1. A mixture of particle sizes with no specific concentration or lack thereof of one or more sizes.
   2. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
   3. Used to define material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

H. Influence Area:
   1. Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
      a. 1 foot outside outermost edge at base of foundations or slabs.
      b. 1 foot outside outermost edge at surface of roadways or shoulder.
      c. 0.5 foot outside exterior at spring line of pipes or culverts.

I. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

J. Selected Backfill Material: Materials available onsite that Engineer determines to be suitable for specific use.

K. Imported Material: Materials obtained from sources offsite, suitable for specified use.

L. Granular Fill: Fill materials as required under structures, pavements, and other facilities.

M. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

O. Proof Rolling: Testing of compactive effort to identify areas that will not support the future loading without excessive settlement.

1.03 SUBMITTALS

A. Informational Submittals:
   1. Manufacturer’s data sheets for compaction equipment.
   2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Engineer when:
   1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
   2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
   3. Fill material appears to be deviating from Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Engineer’s acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-in-Place Concrete.

D. Backfill around buried tanks only after tank is set in position, securely anchored, and ready to be backfilled and Engineer provides authorization to backfill.

E. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.
PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests:
   1. One or more tests as necessary to locate acceptable sources of imported material.
   2. Gradation tests must have been performed within 3 months of submittal.

B. Samples:
   1. Collected in accordance with ASTM D75:
      a. During production of imported material, provide samples and testing as needed to assure consistency of the product. Contractor shall remove and replace material that is found to not meet the specification requirements.
      b. Clearly mark to show source of material and intended use.

2.02 EARTHFILL

A. Excavated material from required excavations and designated borrow sites, free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Provide imported material of equivalent quality, if required to accomplish Work.

C. Gradation of Earthfill shall be well graded from coarse to fine, with no more than 20 percent fines content.

2.03 GRANULAR FILL

A. Aggregate that meets the requirements specified in Section 32 11 23, Aggregate Base and Surfacing Courses.

B. 1-inch minus crushed gravel or crushed rock.

C. Free from dirt, clay balls, and organic material.

D. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.
2.04 REINFORCED SOIL SLOPE FILL

A. Excavated material from required excavations and designated borrow sites, free from rocks larger than 4 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>20 – 100</td>
</tr>
<tr>
<td>No. 40</td>
<td>0 – 60</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 – 50</td>
</tr>
</tbody>
</table>

C. Plasticity Index less than 20, as determined in accordance with ASTM D4318.

D. pH levels greater than 3, as determined in accordance with ASTM G51.

E. Provide imported material of equivalent quality, if required to accomplish Work.

2.05 SAND

A. Free from clay, organic matter, or other deleterious material.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>95 – 100</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 – 8</td>
</tr>
</tbody>
</table>

2.06 BACKFILL AROUND BURIED TANKS

A. As specified for Sand.

2.07 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.
PHASE IV BEAVER CREEK WATER SUPPLY

2.08 WATER FOR MOISTURE CONDITIONING
A. Free of hazardous or toxic contaminants, or contaminants deleterious to proper compaction.

2.09 BASE COURSE ROCK
A. As specified for Base Course in Section 32 11 23, Aggregate Base and Surfacing Courses.

2.10 FOUNDATION STABILIZATION ROCK
A. Crushed rock or pit run rock.
B. Uniformly graded from coarse to fine.
C. Free from excessive dirt and other organic material.
D. Gradation as determined in accordance with ASTM C117 and ASTM C136.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 inches</td>
<td>99 – 100</td>
</tr>
<tr>
<td>2 inches</td>
<td>65 – 100</td>
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<tr>
<td>1 inch</td>
<td>50 – 85</td>
</tr>
<tr>
<td>No. 4</td>
<td>26 – 44</td>
</tr>
<tr>
<td>No. 40</td>
<td>16 max</td>
</tr>
<tr>
<td>No. 200</td>
<td>9 max</td>
</tr>
</tbody>
</table>

2.11 SOIL COVER OVER GEOTEXTILES
A. Particle Size: Maximum 1 inch.
B. Free of sharp angular pieces that may damage geotextile.

PART 3 EXECUTION

3.01 GENERAL
A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.
4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in loose lifts of 8-inch maximum thickness for material compacted with heavy compaction equipment and 6 inches for material compacted with hand-operated tampers. Compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557 Method.
B. Backfill Under All Cast-in-Place Concrete Structures and Slabs: Provide 6 inches of granular fill compacted to at least 95 percent relative compaction as determined in accordance with ASTM D1557.

C. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction within influence areas under facilities, and 90 percent relative compaction in all other areas.

D. Other Areas: Backfill with Earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557.

3.03 BACKFILL AROUND TANKS

A. Backfill to top of tank, unless otherwise shown, with granular fill and thoroughly water settle by saturating backfill and vibrating saturated backfill with a concrete vibrator inserted through full depth of backfill on 1-foot maximum centers.

B. Backfill above top of tank with earthfill placed in 8-inch lifts. Compact each lift to minimum 95 percent relative compaction as determined in accordance with ASTM D1557 Method.

3.04 BACKFILL UNDER MAT FOUNDATIONS

A. Obtain approval from Engineer prior to backfilling on the prepared foundation.

B. Keep excavation areas free of standing water at all times. Provide pumps, sumps and drains as needed to keep all work areas free of water.

C. Place granular fill on the prepared foundation to the thickness and extent shown on Drawings. Do not place in lifts no thicker than 8 inches at one time before compacting.

D. Compaction of the granular fill should be performed with a minimum of three passes of an approved, self-propelled vibratory roller.

E. Grade to the required thickness using a small dozer or other tracked equipment that does not disturb the prepared subgrade.
F. Sides and ends of excavation areas shall be formed in dense undisturbed soils. If the soils are loosened in the process of making the excavation, remove the loose soils so the foundation stabilization rock will bear directly against the undisturbed native soils.

G. Prepare the foundation and place and spread the granular fill as the excavation proceeds. Immediately cover the prepared foundation with the granular fill as soon as a sufficiently large area can be prepared. Do not leave the prepared subgrade open to deteriorate. Keep all water pumped off the prepared subgrade. Do not leave prepared subgrade open overnight.

3.05 FILL

A. Outside influence areas beneath structures, tanks, pavements, curbs, slabs, piping and other facilities:

1. Unless otherwise shown, place earthfill as follows:
   a. Allow for 6-inch thickness of topsoil where required.
   b. Maximum 8-inch thick lifts.
   c. Place and compact fill across full width of embankment.
   d. Compact to minimum 92 percent relative compaction as determined in accordance with ASTM D1557.
   e. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.06 REINFORCED SOIL SLOPES

A. As specified in Section 31 32 33, Reinforced Soil Slopes.

3.07 SAND DRAINAGE BLANKET

A. Place sand in loose lifts of 8-inch maximum thickness for material compacted with heavy compaction equipment and 6 inches for material compacted with hand-operated tampers. Compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557 Method.

3.08 SITE TESTING

A. Gradation:

1. One sample from each 500 tons of finished product or more often as determined by Engineer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests:

1. In accordance with ASTM D6938. During placement of materials, test as follows:
   a. Granular Fill: Four tests every 2 feet of vertical fill placement, evenly distributed across the site.
   b. Reinforced Soil Slope Fill: Two tests every 2 feet of vertical fill placement, evenly distributed across the embankment.
   c. Base Course Rock: One test every 200 linear feet of roadway per lift.
   d. Earthfill: One test every 1,000 square feet of placement.
   e. Granular Backfill Behind Walls: Not less than four tests per each wall.
   f. Sand: Four tests every 2 feet of vertical fill placement, evenly distributed across the site.
   g. Minimum of two tests for each of the major structures, including Membrane Facility, Backwash Basins, Clearwell Tank, and Intake Facility.
   h. Perform additional testing if failing tests occur and/or variable conditions are encountered.

3.09 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base and Surfacing Courses.

3.10 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Engineer as follows:

1. Beneath Footings: Concrete of strength equal to that of respective footing, as specified in Section 03 30 00, Cast-in-Place Concrete.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-on-Grade: Granular fill.
4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited, unless in Engineer’s opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.11 PLACING FILL OVER GEOSYNTHETICS

A. General:
   1. Place fill over geosynthetics with sufficient care so as not to damage them.
   2. Place fill only by back dumping and spreading only.
   3. Dump fill only on previously placed fill.
   4. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.

B. Hauling: Operate hauling equipment on minimum of 3 feet of covering.

C. Spreading:
   1. Spreading equipment shall be track mounted low ground pressure, D-6 or lighter.
   2. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
   3. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
   4. Never push fill downslope. Spread fill over sideslopes by pushing up from slope bottom. If access to bottom of slope is unavailable, progressively place fill, beginning at toe of slope and working upslope, with backhoe or dragline operated from top of slope. Limit distance material falls onto the geosynthetics to maximum of 2 feet.
   5. Flatten wrinkles in direction of spreading. Correct wrinkles in geosynthetics as specified in Section 31 32 19.16, Geotextile.
   7. Avoid overstressing geosynthetics and seams.

D. Compaction: Compact fill only after uniformly spread to full thickness shown.
PHASE IV BEAVER CREEK WATER SUPPLY

E. Geosynthetic Damage:

1. Mark punctures, tears, or other damage to geosynthetics, so repairs may be made.
2. Clear overlying fill as necessary to repair damage.
3. Repairs to geosynthetics shall be made by respective installers as specified in respective specification section for each geosynthetic.

3.12 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base and Surfacing Courses.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. ASTM International (ASTM):
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   i. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
   j. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Dense Graded Aggregate: Crushed rock including sand that is uniformly graded from coarse to fine.

D. Imported Material: Material obtained by Contractor from source(s) offsite.

E. Lift: Loose (uncompacted) layer of material.

F. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable or duct bank.

G. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

H. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Engineer.

I. Selected Backfill Material: Material available onsite that Engineer determines to be suitable for a specific use.

J. Well-Graded: A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids.

1. Satisfying both of the following requirements, as defined in ASTM D2487:
   a. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.
   b. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer’s descriptive literature for marking tapes and tracer wire.

B. Informational Submittals:

1. Catalog and manufacturer’s data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design and test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 GEOTEXTILE

A. As specified in Section 31 32 19.16, Geotextile.

2.02 MARKING TAPE

A. Nondetectable:

1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
2. Thickness: Minimum 5 mils.
3. Width: 3 inches.
4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
5. Manufacturers and Products:
   a. Reef Industries; Terra Tape.
   b. Mutual Industries; Non-detectable Tape.
   c. Presco; Non-detectable Tape.
B. Detectable:

1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
2. Foil Thickness: Minimum 0.35 mils.
3. Laminate Thickness: Minimum 5 mils.
4. Width: Per the manufacturer based on depth of installation.
5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
7. Manufacturers and Products:
   a. Reef Industries; Terra Tape, Sentry Line Detectable.
   b. Mutual Industries; Detectable Tape.
   c. Presco; Detectable Tape.

C. Color: In accordance with APWA Uniform Color Code.

<table>
<thead>
<tr>
<th>Color*</th>
<th>Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Electric power lines, cables, conduit, and lightning cables</td>
</tr>
<tr>
<td>Orange</td>
<td>Communicating alarm or signal lines, cables, or conduit</td>
</tr>
<tr>
<td>Yellow</td>
<td>Gas, oil, steam, petroleum, or gaseous materials</td>
</tr>
<tr>
<td>Green</td>
<td>Sewers and drain lines</td>
</tr>
<tr>
<td>Blue</td>
<td>Potable water</td>
</tr>
<tr>
<td>Purple</td>
<td>Reclaimed water, irrigation, and slurry lines</td>
</tr>
</tbody>
</table>

*As specified in NEMA Z535.1, Safety Color Code.

2.03 TRACER WIRE

A. Material: Minimum 12-gauge solid copper or copper jacket with a steel core, with high-density polyethylene (HDPE) or high-molecular weight polyethylene (HMWPE) insulation suitable for direct bury.

B. Splices: Use wire nut or lug suitable for direct burial as recommended by tracer wire manufacturer.

C. Manufacturers:

1. Copperhead Industries, LLC.
2. Performance Wire & Cable, Inc.
2.04 TRENCH STABILIZATION MATERIAL

A. As specified for Foundation Stabilization Rock in Section 31 23 23, Fill and Backfill.

2.05 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18-Inch Diameter:
   a. For piping from Station 0+90 to Station 58+00 as shown on Drawing 15-C-202 through Drawing 15-C-209: 3/4-inch dense graded aggregate as specified in Section 02630 of the Standard Specifications.
   b. For the 4-inch SN pipeline from Station 0+65 to Station 5+65 as shown on Drawing 15-C-261: 3/4-inch dense graded aggregate as specified in Section 02630 of the Standard Specifications.
   c. For other Piping: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.
5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
   a. For conduit from Station 0+90 to Station 58+00 as shown on Drawing 15-C-202 through Drawing 15-C-209 and Drawing 09-E-200: 3/4-inch dense graded aggregate as specified in Section 02630 of the Standard Specifications.
   b. For other Conduit and Direct buried Cable:
      1) Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
      2) Individual Particles: Free of sharp edges.
      3) Maximum Size Particle: Pass a No. 4 sieve.
      4) If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.
2.06 GRANULAR DRAIN MATERIAL
A. Gradation: As specified in Division 00430.11 of the Standard Specifications for 1-1/4 inch to 3/4 inch designated sizes. See ASTM C117 and ASTM C136 for standard gradation testing.

2.07 GRANULAR BACKFILL
A. As specified in Section 31 23 23, Fill and Backfill, for granular fill.

2.08 EARTHFILL
A. As specified in Section 31 23 23, Fill and Backfill.

2.09 CONTROLLED LOW STRENGTH MATERIAL (CLSM)
A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
B. Materials:
   1. Cement: ASTM C150/C150M, Type I or Type II.
   3. Fly Ash (Pozzolan): Class C fly ash in accordance with ASTM C618.
   4. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.10 CONCRETE BACKFILL
A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.11 LEVELING COURSE
A. As specified in Section 32 11 23, Aggregate Base and Surfacing Courses.

2.12 TOPSOIL
A. As specified in Section 32 91 13, Soil Preparation.

2.13 SOURCE QUALITY CONTROL
A. Perform gradation analysis in accordance with ASTM C136 for:
   1. Earthfill.
   2. Trench stabilization material.
   3. Bedding and pipe zone material.
B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. Promptly remove and dispose of water entering trench as necessary to grade trench bottom and to compact backfill and install manholes, pipe, conduit, direct-buried cable, or duct bank. Do not place concrete, lay pipe, conduit, direct-buried cable, or duct bank in water.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Engineer. Engineer will determine depth of overexcavation, if any required.

3.03 GEOTEXTILE INSTALLATION

A. Where shown and as specified in Section 31 32 19.16, Geotextile, except as follows:

1. Extend geotextile for full width of trench bottom and up the trench wall to the top of the pipe zone, or base material for manholes and miscellaneous structures.
2. Anchor geotextile trench walls prior to placing trench stabilization or bedding material.
3. Provide 24-inch minimum overlap at joints.
3.04 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.05 BEDDING

A. Furnish imported bedding material where, in the opinion of Engineer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness: 4 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.06 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.
C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor only over area between sides of pipe and trench walls.

3.07 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, at depth shown on applicable details. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.

3.08 TRACER WIRE INSTALLATION AND TESTING

A. Install tracer wire continuously along centerline of nonmetallic buried piping.

B. Attach wire to top of pipe using tape at maximum of 10-foot intervals. In areas where depth of cover is excessive for allowing detection of tracer wire with electronic pipe locator, install tracer wire within pipe backfill directly above pipe centerline at a minimum depth of 3 feet.

C. Install splices in accordance with manufacturer’s instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.

D. Bring tracer wire to surface at each valve box, curb box, vault, air valve, blowoff valve, hydrant, and pipeline marker. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Mark valve box cover with the word “TRACER”.

Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.
E. Test continuity of tracer wire using electronic pipe locator in presence of Engineer prior to paving.

3.09 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements if suitable for backfill.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Granular Backfill:

1. For areas under structure influence zone, pavement, and gravel surfacing, use granular backfill.
2. Backfill trench above pipe zone with granular fill or 3/4-inch dense-graded aggregate when specified, to a depth of 9 inches below original ground surface.
3. Place granular backfill in loose lifts of 6 inches at a time, and mechanically compact each lift of granular backfill to a minimum of 95 percent relative compaction prior to placing succeeding lifts.
4. Fill remainder of trench with gravel surfacing rock over entire trench width.
5. Compact gravel surfacing rock as specified in Section 32 11 23, Aggregate Base and Surfacing Courses, over entire trench surface as necessary to prevent settlement.
6. Finish completed backfilled surface at same level as original surface.

C. Earthfill:

1. For areas outside of structure influence zone, pavement, and gravel surfacing, use earthfill.
2. Place earthfill in lifts not exceeding thickness of 9 inches.
3. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.
D. Concrete Backfill:

1. Place above bedding.
2. Minimum Concrete Thickness: 6 inches on top and sides of pipe.
3. Do not allow dirt or foreign material to become mixed with concrete during placement.
4. Allow sufficient time for concrete to reach initial set before additional backfill material is placed in trench.
5. Prevent flotation of pipe.
6. Begin and end concrete backfill within 4 inches of a pipe joint on each end.
7. Do not encase pipe joints except within the limits of the concrete backfill.

E. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screen off excess and finish with a float.
4. In other areas fill trench section as shown on Drawings.

3.10 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 12 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.11 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final surface restoration is completed.

B. Leveling Course: Add leveling course where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.
PHASE IV BEAVER CREEK WATER SUPPLY

E. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.12 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION
SECTION 31 32 19.16
GEOTEXTILE

PART 1    GENERAL

1.01   REFERENCES

A.   The following is a list of standards that may be referenced in this section:

1.   ASTM International (ASTM):
   g.   D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
   n.   D6193, Standard Practice for Stitches and Seams.
1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

G. Structural Geogrid: A structural geogrid is formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer material specifications and product literature.
   b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
   c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.

2. Samples:
   a. Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.
   b. Field Sewn Seam: 5-foot length of seam, 12 inches wide with seam along center, for each type and weight of geotextile.
   c. Securing Pin and Washer: One each.
B. Informational Submittals:
   1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
   2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING
A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.
B. Handle products in manner that maintains undamaged condition.
C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING
A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.
B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer’s approval of underlying materials.

PART 2 PRODUCTS
2.01 NONWOVEN GEOTEXTILE
A. Nonwoven, pervious sheets of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other. Continuous or discontinuous (staple) fibers held together through needle punching, spun bonding, thermal bonding, or resin bonding.
B. Composed of polymeric yarn interlaced to form planar structure with uniform weave pattern.
C. Calendared or finished so yarns will retain their relative position with respect to each other.
D. Polymeric Yarn: Long-chain synthetic polymers (polyester or polypropylene) with stabilizers or inhibitors added to make filaments resistant to deterioration due to heat and ultraviolet light exposure.
PHASE IV BEAVER CREEK WATER SUPPLY

E. Sheet Edges: Selvaged or finished to prevent outer material from separating from sheet.

F. Unseamed Sheet Width: Minimum 6 feet.

G. Nominal Weight per Square Yard: 8 ounces per square yard per ASTM D5261.

H. Physical Properties: Conform to requirements in Table No. 1.

<table>
<thead>
<tr>
<th>Table No. 1</th>
<th>Physical Property Requirements for Nonwoven Geotextile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td>Requirement</td>
</tr>
<tr>
<td>Apparent Opening Size (AOS)</td>
<td>U.S. Standard Sieve Size No. 50 or larger (0.30 mm or smaller)</td>
</tr>
<tr>
<td>Water Permittivity</td>
<td>0.7 sec.-1, MinARV</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>320 lb/in, MinARV</td>
</tr>
<tr>
<td>Grab Elongation</td>
<td>15 percent, MaxARV</td>
</tr>
<tr>
<td>Trapezoidal Tear Strength</td>
<td>125 lb, MinARV</td>
</tr>
<tr>
<td>Ultraviolet Radiation Resistance</td>
<td>70 percent strength retention, MinARV after 500 hours</td>
</tr>
<tr>
<td>Test Method</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ASTM D4751</td>
</tr>
<tr>
<td></td>
<td>ASTM D4491 (Falling Head)</td>
</tr>
<tr>
<td></td>
<td>ASTM D4632</td>
</tr>
<tr>
<td></td>
<td>ASTM D4632</td>
</tr>
<tr>
<td></td>
<td>ASTM D4533</td>
</tr>
<tr>
<td></td>
<td>ASTM D4355</td>
</tr>
</tbody>
</table>

2.02 STRUCTURAL GEOGRID

A. Primary Geogrid:

1. The primary geogrid shall provide the following allowable tensile properties:

<table>
<thead>
<tr>
<th>Table No. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property Method</td>
</tr>
<tr>
<td>Long-Term (T_a), lbs/ft *</td>
</tr>
</tbody>
</table>

* Where: 

\[ T_a = \frac{T_{ULT}}{RF_{CR} \times RF_{ID} \times RF_{D}} \]
2. **T\textsubscript{ULT}:** Ultimate Tensile Strength shall be the minimum average roll value ultimate tensile strength as tested per ASTM D6637. This test shall be conducted without artificially deforming test materials under load before measuring such resistance or employing an artificial “secant” or “offset” tangent basis of measurement so as to overstate tensile properties.

3. **RF\textsubscript{CR}:**
   a. The Reduction Factor for Creep is the ratio of T\textsubscript{ULT} divided by the creep-limited strength determined in accordance with ASTM D5262. Long-term tension-strain-time behavior of the reinforcement shall be determined from controlled laboratory testing conducted for a minimum duration of 10,000 hours. The requirement for the minimum creep test period may be waived for a new product if it can be demonstrated that it is sufficiently similar to a proven 10,000-hour creep tested product. When these conditions are met, creep testing shall be conducted for at least 1,000 hours and the results compared to the similar product tested for 10,000 hours. The 1,000-hour creep curves must pattern very closely to the 1,000-hour creep curves of the similar product to demonstrate equivalency. Creep test data at a given temperature may be extrapolated over time by one order of magnitude. Accelerated testing is required to extrapolate 10,000-hour creep data to a 75-year design life. Procedures for test acceleration are discussed in GRI-GG4. Creep testing is required on representative samples of the finished product and not a single component of the geogrid (e.g., fiber and/or yarn). The ultimate strength used in this calculation shall be that of the roll used in the testing and not the MinARV for the product. Creep rupture testing that has been performed through the use of alternative techniques (e.g., stepped Isothermal method) must be supported with creep data conducted for a minimum of 10,000 hours at 20 degrees C.
   b. In no event shall the minimum value of F\textsubscript{SCR} be less than:
      1) PVC-Coated and PET Geogrid: 1.75.
      2) Acrylic-Coated PET Geogrid: 1.75.
      3) HDPE Uniaxial Geogrid: 2.15.
      4) PP Biaxial Geogrid: 4.00.
   c. **RFID:** Reduction Factor for installation damage shall be as shown in Table No. 3.

<table>
<thead>
<tr>
<th>No.</th>
<th>Geosynthetic</th>
<th>RFID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HDPE uniaxial geogrid</td>
<td>1.20 – 1.45</td>
</tr>
</tbody>
</table>

**Table No. 3**

Reduction Factor for Installation Damage, RF\textsubscript{ID}
Table No. 3
Reduction Factor for Installation Damage, $RF_{ID}$

<table>
<thead>
<tr>
<th>No.</th>
<th>Geosynthetic</th>
<th>RF Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>PP biaxial geogrid</td>
<td>1.20 – 1.45</td>
</tr>
<tr>
<td>3</td>
<td>PVC coated PET geogrid</td>
<td>1.30 – 1.85</td>
</tr>
<tr>
<td>4</td>
<td>Acrylic coated PET geogrid</td>
<td>1.30 – 2.05</td>
</tr>
</tbody>
</table>

* Minimum weight 270 g/m² (7.9 oz/yd²)

d. $RF_D$: The minimum reduction factor for durability/aging for HDPE and PP shall be 1.0. The minimum reduction factors for PET geogrids are as follows:

<table>
<thead>
<tr>
<th>Product</th>
<th>Reinforced and Retained Fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyester Geogrids</td>
<td>1.6</td>
</tr>
<tr>
<td>$M_n &lt; 20,000; 40 &lt; CEG &lt; 50$</td>
<td></td>
</tr>
<tr>
<td>Polyester Geogrids</td>
<td>1.15</td>
</tr>
<tr>
<td>$M_n &gt; 25,000; CEG &lt; 30$</td>
<td></td>
</tr>
</tbody>
</table>

CEG = carbonyl end group
$M_n$ = number/average molecular weight

2.03 SECONDARY GEOGRID

A. The secondary geogrid shall meet the following minimum average physical property requirements:

| Table No. 4
| Property Method Secondary Reinforcement Type |
| LOAD CAPACITY                  |
| Tensile Strength               |
| @ 2% Strain, lbs/ft            | ASTM D6637 450               |
| @ 5% Strain, lbs/ft            | ASTM D6637 920               |

2.04 SEWING THREAD

A. Polypropylene, polyester, or Kevlar thread.

B. Durability: Equal to or greater than durability of geotextile sewn.
2.05 SECURING PINS

A. Steel Rods or Bars:
   1. 3/16-inch diameter.
   2. Pointed at one end.
   3. With head on other end sufficiently large to retain washer.

B. Steel Washers for Securing Pins:
   1. Outside Diameter: Not less than 1.5 inches.
   2. Inside Diameter: 1/4 inch.
   3. Thickness: 1/8 inch.

C. Steel Wire Staples:
   1. U-shaped.
   2. 10 gauge.

2.06 SEPARATION GEOTEXTILE

A. Nonwoven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; complying with AASHTO M288 and ODOT Standard Specifications.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and to extend at least 18 inches beyond toe of slope.
3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
   b. Riprap: Minimum 18 inches.
   c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
   d. Other Applications: Minimum 12 inches.

B. Sewn Seams: Made wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam Efficiency:
   a. Minimum 80 percent.
   b. Verified by preparing and testing minimum of one set of nondestructive Samples per acre of each type and weight of geotextile installed.
   c. Tested according to ASTM D4884.

2. Types:
   a. Preferred: “J” type seams.
   b. Acceptable: Flat or butterfly seams.

3. Stitch Count: Minimum three to maximum seven stitches per inch.
4. Stitch Type: Double-thread chain stitch according to ASTM D6193.
5. Sewing Machines: Capable of penetrating four layers of geotextile.
6. Stitch Location: 2 inches from geotextile sheet edges, or more, if necessary to develop required seam strength.

3.04 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by Engineer.

B. Secure Geotextile with Securing Pins or Staples:

1. Insert securing pins with washers through geotextile.
2. Securing Pin Alignment:
   a. Midway between edges of overlaps.
   b. 6 inches from free edges.
3. Spacing of Securing Pins:

<table>
<thead>
<tr>
<th>Slope</th>
<th>Maximum Pin Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steeper than 3:1</td>
<td>2 feet</td>
</tr>
<tr>
<td>3:1 to 4:1</td>
<td>3 feet</td>
</tr>
<tr>
<td>Flatter than 4:1</td>
<td>5 feet</td>
</tr>
</tbody>
</table>

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.

5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.

6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in to secure geotextile firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way to completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 GEOTEXTILE-REINFORCED EARTH WALL APPLICATIONS

A. Sew exposed joints; extend sewn seams minimum 3 feet behind face of wall.

B. Protect exposed geotextile from damage, ultraviolet light exposure, and deterioration until permanent facing is applied.
3.08 REINFORCED SOIL SLOPE APPLICATIONS
   
   A. Use of geogrid for reinforced soil slopes shall follow the requirements in Section 31.32.33, Reinforced Soil Slopes.

3.09 SILT FENCE APPLICATIONS

   A. Install geotextile in one piece, or continuously sewn to make one piece, for full length and height of fence, including portion of geotextile buried in toe trench.

   B. Install bottom edge of sheet in toe trench and backfill in a way that securely anchors geotextile in trench.

   C. Securely fasten geotextile to wire mesh backing and each support post in a way that will not result in tearing of geotextile when fence is subjected to service loads.

   D. Promptly repair or replace silt fence that becomes damaged.

3.10 REPAIRING GEOTEXTILE

   A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

   B. Repair Procedure:

      1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.

      2. Remove interfering material as necessary to expose damaged geotextile for repair.

      3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

3.11 REPLACING CONTAMINATED GEOTEXTILE

   A. Protect geotextile from contamination that would interfere, in Engineer’s opinion, with its intended function. Remove and replace contaminated geotextile with clean geotextile.

   END OF SECTION
PART 1  GENERAL

1.01 WORK INCLUDED

A. Biotechnical/streambank stabilization consists of construction of FESL, brushlayers, and placement of live cuttings along stream slopes disturbed during construction of other project components.

B. FESL is defined as fabric-encapsulated soil lifts, identified on Drawings along stream slopes. FESL is a construction technique used to stabilize streambanks as shown on Drawings. FESL includes other components including geotextile used in FESL construction, brushlayer, live fascine, live stakes, and drip tubing.

C. FESL shall be constructed as detailed on Drawings, and consist of a wrap of both fine and dense erosion control blanket (ECB, also referred to as Geotextile in this specification) for each lift. The lower lift shall include installation of a live fascine at the face of the lift, within the layers of ECB. A brushlayer shall also be installed between each lift, including irrigation drip tubing (see Article Irrigation Drip Tubing).

1.02 WORK INCLUDED

A. Additional excavation/backfill to construct FESL at locations shown on Drawings. All runs of FESL shall include excavation/backfill necessary to construct FESL end detail at both the upstream and downstream limits of FESL at every location.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D3776, Standard Test Methods for Mass Per Unit Area (Weight of Fabric).
1.04 DEFINITIONS

A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7 percent degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.05 RELATED SECTIONS

A. Section 32 92 00, Turf and Grasses.
B. Section 32 93 00, Plants.

1.06 SUBMITTALS

A. Certification: The Contractor shall provide to the Engineer a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile. The certification shall state that the furnished geotextile meets MARV requirements of the specification as evaluated under the manufacturer’s quality control program. The certification shall be attested to by a person having legal authority to bind the manufacturer.

B. Samples: One piece of each type of geotextile, minimum 12 inches long, taken across full width of roll of each type and weight of geotextile furnished for the Project. Label each with brand name and furnish documentation of lot and roll number from which each sample was obtained.

C. Live Stakes: Refer to Article Submittals in Section 32 93 00, Plants.

PART 2 PRODUCTS

2.01 BACKFILL FOR FABRIC-ENCAPSULATED SOIL LIFT (FESL)

A. Backfill material for FESL shall be the native material from required excavations, free from rocks larger than 6 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials. Final backfill material shall be approved by the Engineer before placement.

B. Graded from coarse to fine with less than 20 percent material by weight passing the No. 40 sieve.
2.02 GEOTEXTILE USED IN FESL CONSTRUCTION

A. Delivery, Storage, Handling:

1. Deliver each roll of geotextile with sufficient information attached to identify it for inventory and quality control. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.
2. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.
3. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following:
   a. Site construction damage, precipitation, extended ultraviolet radiation, including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, excess temperatures, and any other environmental conditions that may damage the physical property values of the geotextile.

B. Scheduling and Sequencing: Notify the Engineer whenever FESL geotextiles are to be placed. Do not place geotextile without Engineer’s approval of underlying materials.

C. FESL Erosion Control Blanket:

1. Coarse Erosion Control Blanket:
   a. Coarse erosion control blanket (ECB) used within the FESL as shown on Drawings shall meet the following requirements:
      1) Made of natural coir fiber material.
      2) Have a functional longevity of at least 3 years.
      3) Have a maximum aperture size of 1 inch.
      4) Have a minimum weight of 25 ounces per square yard, as measured by ASTM D3776 or other qualified independent tests determined acceptable by the Engineer.
      5) Have a minimum dry/wet tensile strength of 1,900/1,250 pounds per foot as measured by ASTM D4595.
   b. Manufacturer and Product:
      b) "Or-equal."

2.03 STAKES

A. Dead Stakes: Tapered wooden stakes or manufactured wooden stakes, with a minimum dimension of 1/2 inch by 1 inch in section, or dimensional lumber (such as a 2 by 4) cut diagonally lengthwise to produce two stakes. Length of dead stakes shall be as required to achieve the function of anchoring geotextile as shown on Drawings, or 18 inches, whichever is greater.
B. Live Stakes:

1. Refer to Section 329300, Plants.
2. The approximate number and species distribution of live cuttings required to construct FESL, live fascine, brushlayer, and used as live stakes is listed on Drawings.
3. Live stakes installed by driving through top of FESL layers (not in brushlayer) shall be 2 feet to 4 feet in length, and 1/2 inch to 2 inches in diameter. Live stakes installed between layers of FESL, refer to Article Brushlayer.
4. Live stakes installed at locations other than FESL layers shall be of the diameter and length shown on Drawings.
5. Trim all leaves and secondary branches from cuttings prior to storage or installation.

2.04 LIVE FASCINE

A. Live cuttings collected for live fascine shall be of the same species mix, number, harvest proportions, condition, and cared for as described above in Article Stakes, Paragraph Live Stakes.

B. Live stakes installed in live fascine shall be greater than or equal to 5 feet in length, and have a diameter less than 1 inch.

C. Live fascine shall be prepared from long slender straight branches, in bundles ranging from 6 inches to 8 inches in diameter, installed in the leading edge of the lowermost FESL lift, as shown on Drawings. Length of individual cuttings can vary.

2.05 BRUSHLAYER

A. Live stakes installed in brushlayer shall be long slender branches, with lengths ranging from 4 feet to 8 feet, and constructed as shown on Drawings.

PART 3 EXECUTION

3.01 BACKFILLING FESL

A. Backfill of FESL lifts shall consist of native soils, but shall not include any particles larger than 6 inches. Backfill shall be placed and compacted in 6-inch thick lifts.

B. Compact FESL backfill to approximately 80 percent relative density in accordance with ASTM D1557.
3.02 LAYING GEOTEXTILE

A. Place fine and coarse ECB to construct FESL as shown on Drawings and as directed by the Engineer. Place ECB and maintain smooth and free of folds, wrinkles, or creases, and taut at the rounded face of FESL lifts. Orient ECB layers with long dimension of each sheet parallel to direction of slope (e.g., perpendicular to the direction of stream flow). Overlap joints a minimum of 1 foot.

3.03 SECURING GEOTEXTILE

A. For FESL zones, secure ECB with dead stakes or live stakes (see Section 32 93 00, Plants), driven through the ECB geotextile a minimum of 1 foot, midway between edges of overlaps, and at least 8 inches from free edges. Install stakes across each ECB sheet as necessary to prevent slippage. Drive each stake through ECB geotextile until the larger end of a tapered dead stake secures the ECB firmly to the subgrade. Only install live stakes in the uppermost layer of FESL, or in front of next lift, as shown on Drawings.

B. For FESL zones, dead stakes shall be spaced a maximum of 2 feet apart. Install additional stakes as necessary.

C. For applications other than FESL zones, anchor and secure geotextile in accordance with the manufacturer’s recommendations, unless otherwise shown on Drawings or described within this specification.

D. Live stakes shall be spaced a maximum of 4 feet apart.

3.04 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair shall involve placing and securing an undamaged patch of the same material, which overlaps the damaged area a minimum of 2 feet in all directions.

C. Any geotextile piece that is torn within 3 feet of the face of the FESL lift shall be replaced.

3.05 INSTALLING LIVE STAKES

A. Live stakes shall be driven into the openings or interstices between geotextile or in native earthfill on the specified slopes and surfaces, at a right angle to the slope, with the growing tips oriented upward.
B. Tamp the live stake into the slope using a dead blow hammer (hammer with the head filled with lead shot) in order to avoid splitting the stakes, or otherwise protect the top of the cutting from damage.

C. The basal end of the stake shall be trimmed on an angle to facilitate penetration into the slope, and to protect the stake during installation and to distinguish ends to ensure proper orientation. The top end of the stake shall be cut square.

D. If necessary prior to installation, first create an opening or pilot hole in the surface or geotextile using an iron bar or rod. Any live stakes that are damaged during installation (bent, broken, split, or bark stripped off) shall be replaced at the Contractor’s expense.

E. Live stakes shall be driven until 20 percent or less of the length of the live stake is left exposed above the finished ground surface, not to exceed a length of 8 inches.

F. Live stakes shall be installed on the required slopes in a random configuration with approximately equal spacing.

3.06 INSTALLING LIVE FASCINE

A. Install cuttings for live fascine in a bundle inside the leading edge of the lowermost FESL lift, as shown on Drawings.

B. Backfill openings within the live fascine bundle with topsoil before covering with geotextile.

3.07 INSTALLING BRUSHLAYER

A. Brushlayers shall be constructed by placing live cuttings between successive lifts of FESL, and also placed within the upper slope stabilization zone, as shown on Drawings.

B. Place live cuttings on FESL lift, and backfill openings between cuttings with topsoil before placing next successive geotextile lift.

C. All the growing tips for brushlayers shall be aligned in the same direction, protruding out of the completed slope, within FESL zones and within upper slope stabilization zones.

D. Live cuttings for brushlayer shall extend between 1 foot and 2 feet beyond the face of the finished slope, not to exceed 20 percent of the total length of the cutting.
E. Live cuttings for brushlayer shall be placed at a density of 15 to 20 cuttings per linear foot within each brushlayer row.

3.08 FESL AND BRUSHLAYER IRRIGATION WATERING

A. The water source for FESL and brushlayer irrigation watering shall be determined by the Contractor, to provide the necessary supply of water for the area and number of live cuttings, and dependent upon weather conditions.

B. The FESL and brushlayer irrigation period will begin immediately after installation of FESL and brushlayers, and continue for a full calendar year starting at the time of installation, excluding the dormancy period. During the FESL irrigation period, the Contractor is required to provide all labor, equipment, and maintenance necessary to provide sufficient water to ensure survival of all live cuttings used within the FESL and brushlayers during the period of the Contractor having a presence at the Site. Thereafter, all operation and maintenance of irrigation for the FESL shall be performed by the Owner.

C. Irrigation of FESL and brushlayers will be required on a frequency as determined by the Engineer. Unless notified otherwise, the Contractor shall be required to water individual FESL and brushlayer zones for a suitable duration to supply the necessary water to the size of the zone and number of plants, twice per week.

3.09 LIVE STAKE WATERING

A. The water source for watering live stakes shall be determined by the Contractor, to provide the necessary supply of water for the area and number of live stakes, and dependent upon weather conditions.

B. The live stake watering period will begin immediately after installation of live stakes, and continue for a full calendar year starting at the time of installation, excluding the dormancy period.

END OF SECTION
SECTION 31 32 33
REINFORCED SOIL SLOPES

PART 1 GENERAL

1.01 DESCRIPTION

A. Work shall consist of furnishing and testing materials and the construction of a reinforced soil slope (RSS) retention system. Work consists of:

1. Furnishing structural geogrid reinforcement, as shown on Drawings.
2. Storing, cutting, and placing structural geogrid reinforcement, as specified herein and as shown on Drawings.
3. Providing phone and onsite access to supplier representatives for preconstruction meeting with Contractor and Engineer.
4. Excavating, placing and compacting of reinforced fill material, as specified herein and as shown on Drawings.

1.02 ALTERNATES

A. Geotextile materials will not be considered as an alternate to geogrid materials. Geotextile may be used to provide separation, filtration, or drainage; however, no structural contribution will be attributed to the geotextile.

B. Alternate geogrid materials shall not be used unless submitted to the Engineer and approved in writing by the Engineer at least 10 days prior to the Bid. The Engineer shall have absolute authority to reject or accept alternate materials based on the requirements of this section and the Engineer’s judgement.

1.03 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):

1.04 DEFINITIONS

A. Fill: Soil or aggregate placed in, behind, or below the embankment or slope.

B. Reinforced Backfill: Soil which is placed and compacted within the volume of reinforcement as outlined on Drawings.

C. Foundation Soil: Compacted, imported, or in-situ soil beneath the entire reinforced soil slope.

D. Structural Geogrid: A structural geogrid is formed by a regular network of integrally connected tensile elements with apertures of sufficient size to allow interlocking with surrounding soil, rock, or earth and function primarily as reinforcement.

1.05 SUBMITTALS

A. At least 20 days prior to delivery of materials to the Site, the Contractor shall submit:

1. Detailed Drawings for approval. Shop Drawings shall include product layout and methods of splicing and overlapping, if used.

2. Four geogrid product samples approximately 4 inches by 7 inches or larger and consisting of at least four entire apertures.

3. Manufacturer’s installation instructions and general recommendations.

4. A list of 10 comparable projects that are similar in terms of size and application, are located in the United States, and where the results of using the specific geogrid material can be verified after a minimum of 3 years of service life.

5. Certified specification sheets.

1.06 QUALITY ASSURANCE

A. Preconstruction conference: prior to the installation of the geogrid, the Contractor shall arrange a meeting at the Site with the geogrid material supplier and the geogrid installer. The geogrid supplier shall be experienced in the design and construction of reinforced soil slope systems. The Owner and the Engineer shall be notified at least 3 days in advance of the time of the meeting. The representative of the geogrid supplier shall be available on an “as-needed” basis during construction.
1.07 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall check all materials upon delivery to assure that the proper type, grade, color and material certification have been received. Contractor shall protect materials from damage due to jobsite conditions and in accordance with the manufacturer’s recommendations. Damaged materials shall not be incorporated into the work.

B. Labeling: Label each roll with the manufacturer’s name, product identification, roll dimensions, lot number and date manufactured.

C. Handling: Geosynthetic rolls shall be handled and unloaded by hand, or with load carrying straps, a fork lift with a stinger bar, or an axial bar assembly. Geosynthetic rolls shall not be dragged, lifted by one end, lifted by cables or chains, or dropped to the ground.

D. Storage:
   1. Prevent mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to the geogrid materials.
   2. Store at temperatures above minus 20 degrees F (minus 29 degrees C).
   3. Geosynthetics shall not be exposed to direct sunlight for more than 7 days.
   4. Rolled materials may be laid flat or stood on end.

PART 2 PRODUCTS

2.01 STRUCTURAL GEOGRID

A. Primary Geogrid: As specified for Structural Geogrid in Section 31 32 19.16, Geotextile.

2.02 SECONDARY GEOGRID

A. As specified for Secondary Geogrid in Section 31 32 19.16, Geotextile.

2.03 REINFORCED BACKFILL

A. As specified for Reinforced Soil Slope Fill in Section 31 23 23, Fill and Backfill.

2.04 FOUNDATION SOIL

A. As specified for Granular Fill in Section 31 23 23, Fill and Backfill.
2.05 EROSION CONTROL BLANKET

A. Temporary erosion control blanket as specified in Section 01 57 13, Temporary Erosion and Sediment Control.

PART 3 EXECUTION

3.01 EXAMINATION

A. The Contractor shall check the geogrid upon delivery to verify that the proper material has been received. The geogrid shall be inspected by the Contractor to confirm that the geogrid is free of flaws or damage occurring during manufacturing, shipping, or handling.

3.02 SUBGRADE PREPARATION

A. The subgrade soil shall be excavated to the lines and grades as shown on Drawings and outlined in Section 31 23 23, Fill and Backfill, or as directed by the Engineer.

B. Subgrade to be compacted as required in Section 31 23 13, Subgrade Preparation.

C. Any cut slope surfaces shall be benched to allow the reinforced soil slope to be keyed into the existing slope as shown on Drawings.

D. Prior to geogrid placement, the foundation soils shall be compacted with a smooth, vibratory roller.

E. Any foundation soils found to be unsuitable shall be removed and replaced, as directed by the Engineer.

F. Water shall be diverted from the area where soil reinforcement is being placed and soil is being compacted. Diversion shall be performed using a method approved by the Engineer.

3.03 REINFORCEMENT PLACEMENT

A. Before placing reinforcement, compact the subgrade or subsequent lift of fill and level-grade it. The surface shall be smooth and free of windrows and rocks.

B. Reinforcement shall be placed at the elevations and to the extent shown on Drawings and the approved Shop Drawings submittal, or as directed by the Engineer.
C. Correct orientation (roll direction) of the geogrid shall be verified by the Contractor.

D. Geogrid may be temporarily secured in place with staples, pins, sand bags, or backfill as required by fill properties, fill placement procedures, or weather conditions, or as directed by the Engineer.

E. Install the reinforcement in tension. The reinforcement shall be pulled taut and anchored with staples or stakes prior to placing the overlying lift of fill. The tension shall be uniform along the length of the slope and consistent between layers.

F. All reinforcement shall be 100 percent covered by fill so that reinforcement panels do not contact in overlaps. Where the slope bends, a veneer of fill shall be placed to a nominal thickness of 3 inches to separate overlapping reinforcement.

G. Geogrid soil reinforcement shall be connected/spliced when required to provide continuity of tensile resistance. Geogrids manufactured using polyolefins (e.g., HDPE and PP) shall be connected with a mechanical polymer bar. Geogrids manufactured of polyester shall be connected by sewing with Kevlar sewing thread perpendicular to the direction of loading at the ends of the materials.

3.04 FILL PLACEMENT OVER GEOGRID

A. Reinforced backfill shall be placed in finished lifts no more than 8 inches thick, compacted to 90 percent relative compaction, as outlined in ASTM D1557, except that 95 percent is required within 2 feet of the finish grade. Backfill shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in and/or movement of the geogrid.

B. Tracked construction equipment shall not be operated directly on the geogrid. A minimum fill thickness of 8 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles shall be avoided to prevent tracks from displacing the fill and damaging the geogrid. Rubber-tired equipment may pass over polyolefin geogrid reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided. Rubber-tired equipment shall not pass over polyester geogrid reinforcement. A minimum fill thickness of 9 inches is required prior to operation of rubber-tired equipment over polyester geogrid reinforcement.

C. Contractor shall use whatever means are necessary to compact backfill in all locations, including the outside edge of the embankment. Restrictions on operating power equipment adjacent to existing structures and compaction
testing requirements are specified in Section 31 23 23, Fill and Backfill. Overbuilding, then cutting back the fill may be necessary.

D. Control of moisture in the fill shall be maintained to provide acceptable compaction. Disking and plowing will not be allowed in the reinforced fill zone. Adding water directly to the reinforced fill zone shall only be conducted under conditions where the soil has sufficient porosity and capillarity to provide uniform moisture through the fill during compaction.

3.05 EROSION CONTROL MATERIAL INSTALLATION

A. Temporary Erosion Control: As specified in Section 01 57 13, Temporary Erosion and Sediment Control.

3.06 REPAIR

A. Any geogrid damaged during installation shall be replaced by the Contractor at no additional cost to the Owner.

B. Coated geogrids shall not be used if the coating is torn, shredded, cracked, punctured, flawed, or cut, unless a repair procedure is carried out as approved by the Engineer. The repair procedure shall include placing suitable patch over the defective area or applying a coating solution identical to the original coating.

3.07 PROTECTION

A. Follow the manufacturer’s recommendations regarding protection from exposure to sunlight.

3.08 FINAL SLOPE GEOMETRY VERIFICATION

A. Contractor shall confirm that as-built slope geometries conform to approximate geometries shown on Drawings.

3.09 INSTALLING POSTS THROUGH REINFORCED FILL

A. Limit post hole size to the diameter shown on Drawings.

B. Consult manufacturer and provide additional confinement, use hand tools, or other means to limit soil and geogrid disturbance to immediate area of post hole.

C. Recompacted disturbed soil as necessary.

END OF SECTION
PART 1 GENERAL

1.01 GENERAL

A. Minimum limits are shown on Drawings. It will be the Contractor’s responsibility to determine if additional limits are necessary based on the Contractor’s construction methods and sequence.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation support plan signed and stamped by an engineer licensed in the State of Oregon.
3. Movement measurement and data and reduced results indicating movement trends.
4. Shoring calculations signed and stamped by an engineer licensed in the State of Oregon.

1.03 QUALITY ASSURANCE

A. Provide surveys to monitor movements of critical facilities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Design, provide, and maintain shoring, sheeting, and bracing as necessary to support the sides of excavations and to prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed the Work.

B. Protect existing and new buildings, structures, active sewer, water, gas, electric, and other utility services.

C. Contractor is solely responsible for protection of personnel and existing facilities and utilities.
D. The Contractor shall have in the shoring and temporary support work areas during all phases of construction activities a Responsible Competent Person – a person capable of identifying hazards and anomalies.

3.02 EXCAVATION SUPPORT PLAN

A. Prepare excavation support plan addressing following topics:

1. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
2. Design assumptions and calculations.
3. Methods and sequencing of installing excavation support.
4. Proposed locations of stockpiled excavated material.
5. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
6. Anticipated difficulties and proposed resolutions.

3.03 MOVEMENT MONITORING PLAN

A. Prepare movement monitoring plan addressing following topics:

1. Survey control.
2. Location of monitoring points.
3. Plots of data trends.
4. Interval between surveys.

3.04 REMOVAL OF EXCAVATION SUPPORT

A. Remove excavation support in a manner that will maintain support as excavation is backfilled.

B. Do not begin to remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

C. Remove excavation support in a manner that does not leave voids in the backfill.

3.05 TRENCHES

A. For trench excavation exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable state and local construction safety orders, and federal requirements, including Occupational Safety and Health Act (OSHA) Section 29 CFR 1926.651 and Section 29 CFR 1926.652.

END OF SECTION
PART 1     GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this Section:

2. American Welding Society (AWS):
3. Association of Drilled Shaft Contractors (ADSC) The International Association of Foundation Drilling:
   a. GEC No. 4, Ground Anchors and Anchored Systems.
   b. ADSC Mechanical Anchor Product Data.
4. ASTM International (ASTM):
   b. A36/A36M, Structural Steel.
   c. A53, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   d. A153, Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   e. A252, Welded and Seamless Steel Pipe Piles.
   g. A320/A320M, Alloy-Steel Bolting Materials for Low Temperature Service.
   i. A500, Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   k. A572, HSLA Columbium-Vanadium Steels of Structural Quality.
   l. A615, Standard Specification for Deformed and Plain Steel Bars for Concrete Reinforcement.
   m. A775, Electrostatic Epoxy Coating.
o. A1018, Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability.
q. D1785, Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
r. D3034, Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

1.02 DEFINITIONS

A. Bearing Stratum: Soil layer(s) of sufficient strength capable of resisting the applied axial load transferred by the helical pile.

B. Coupling: Central steel shaft connection means formed as integral part of the plain extension shaft material.

C. Coupling Bolts: High Strength, structural steel fasteners used to connect helical pile segments together.

D. Design Load (DL): Maximum anticipated service load applied to the helical pile.

E. Free Length: Length of plain extension acting as a tendon, which is free to elongate elastically.

F. Helical Pile: Bearing type pile used to transfer compression loads to soil. Helical piles consist of a central steel shaft, helix bearing plates, coatings, corrosion protection, and a wall connection.

G. Helical Extension: Helical pile component installed immediately following the lead or starter section if required. This component consists of one or more helix plates welded to a central steel shaft of finite length. Function is to increase bearing area.

H. Helix Plate: Generally round steel plate formed into a ramped spiral. The helical shape provides the means to install the helical pile, plus the plate transfers load to soil in end-bearing. Helix plates are available in various diameters and thicknesses.
I. Lead Section: The first helical tieback pile component installed into the soil, consisting of single or multiple helix plates welded to a central steel shaft.

J. Plain Extension: Central steel shaft of finite length without helix plates. It is installed following the installation of the lead or starter section or helical extension (if used). The units are connected with couplings and bolts. Plain extensions are used to extend the helix plates beyond the specified minimum free length and into competent load bearing stratum.

K. Safety Factor: The ratio of the ultimate capacity to the working or design load used for the design of any structural element.

L. Thread Bar Adapter: Section of central steel shaft used to connect the helical pile to the wall face via a high tensile strength prestressing thread bar.

M. Torque Strength Rating: The maximum torque energy that can be applied to the helical pile during installation in soil.

1.03 SUBMITTALS

A. Action Submittals:

1. Provide Shop Drawing details showing the pile components and quantities, including the following:
   a. Helical pile number, location, and pattern by assigned identification number.
   b. Helical pile capacities.
   c. Type and size of central steel shaft.
   d. Helix configuration.
   e. Minimum effective torque required.
   f. Connection details.

2. Detailed description of the construction procedures proposed for use, including a list of the major equipment to be used.

3. Certified mill test reports for the central steel shaft.

4. Preproduction and production testing plans for helical pile load testing.

5. Calibration reports for each torque indicator or torque motor, and all load test equipment to be used on the Project. The calibration tests shall have been performed within 45 working days of the date submitted. Calibration reports shall include, but are not limited to, the following:
   a. Name of Project and Subcontractor.
   b. Name of testing agency.
   c. Identification (serial number) of device calibrated.
   d. Description of calibrated testing equipment.
   e. Date of calibration.
   f. Calibration data.
PHASE IV BEAVER CREEK WATER SUPPLY

B. Informational Submittals:

1. Subcontractor’s Qualifications.
2. Installation Records:
   a. Name of Project and Subcontractor.
   b. Name of Subcontractor’s supervisor during installation.
   c. Date and time of installation.
   d. Name and model of installation equipment.
   e. Type of torque indicator used.
   f. Location of helical pile by assigned identification number.
   g. Elevation of pile.
   h. Actual helical pile type and configuration, including lead/starter section, number, and type of extension sections.
   i. Helical pile installation duration and observations.
   j. Total length of installed helical pile.
   k. Inclination of helical pile.
   l. Installation torque at 1-foot intervals for the final 10 feet.
   m. Comments pertaining to interruptions, obstructions, or other relevant information.
   n. Rated load capacities.

3. Warranty: Manufacturer’s Warranty.

1.04 HELICAL PILE DESIGN CRITERIA

A. Helical piles shall meet the torque and load requirements as shown on Drawings.

B. Helical piles shall meet the minimum helix size and pile length as shown on Drawings.

C. The helical piles should have one helical plate, bearing within the stiff, young siltstone layer. The helical plate should have a minimum embedment of 5 feet into the siltstone layer, and bearing at elevation minus 15 feet (EL -15 feet) or deeper.

1.05 QUALITY ASSURANCE

A. Qualifications: The helical pile Subcontractor shall be experienced in performing design and construction of helical piles and shall furnish all materials, labor, and supervision to perform the Work. The Subcontractor shall be trained by the helical pile manufacturer in the proper methods of design and installation of the helical piles. The Subcontractor shall provide the names and qualifications of onsite personnel materially involved with the Work. At a minimum, these personnel shall include foreman, machine operator, and Project Engineer/Manager.
B. The Subcontractor shall be authorized by the helical pile manufacturer to install helical piles. The Subcontractor shall have satisfied the requirements relative to the technical aspects of the product and installation procedures as therein specified.

C. The Subcontractor shall employ an adequate number of skilled workers who are experienced in the necessary crafts and who are familiar with the specified requirements and methods needed for proper performance of the Work in this Section.

D. Helical pile components shall be manufactured by a facility whose quality control systems comply with ISO 9001 requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Transport, store and handle piles in a manner to prevent damage to the piles. Piles shall be stored above the ground surface by pallets, blocking, or other means.

1.07 ALLOWABLE TOLERANCES

A. Centerline of helical pile shall not be more than 3 inches from the indicated location on Drawings.

B. Helical pile plumbness to be within 2 degrees of the design alignment shown on Drawings.

PART 2 PRODUCTS

2.01 HELICAL PILES

A. Helical piles shall consist of lead sections, helical extensions, and plain extensions.

B. Helical piles shall be hot rolled round-cornered-square solid steel bars meeting the dimensional and workmanship requirements of ASTM A29. The bar shall be modified medium carbon steel grade (similar to AISI 1044) with improved strength due to fine grain size.

1. Torsional Strength Rating: Minimum as shown on Drawings.
2. Minimum Yield Strength: 70 ksi.
C. Helix Bearing Plates shall be hot rolled carbon steel sheet, strip, or plate formed on matching metal dies to true helical shape and uniform pitch. Bearing plate shall conform to ASTM A572, ASTM A1018, or ASTM A656 with minimum yield strength of 50 ksi. Plates should have a minimum thickness of 3/8 inch.

D. The size and type of bolts used to connect the central steel shaft sections together shall conform to ASTM A325, ASTM A320, Grade L7, or ASTM A193, Grade B7.

E. Couplings shall be formed as an integral part of the plain and helical extension material as hot upset forged sockets.

F. Helical pile thread bar shall be either a threaded stud adapter, or a combination of prestressing steel tendon and ductile iron or forged steel adapter, both of which are attached to the previously installed central steel shaft via an integrally forged socket or cast steel socket and coupling bolt. Tendon shall be a continuous thread steel bar of specified diameter and length depending on the application and load, per ASTM A615 (Dywidag bar or Williams All-Thread Rebar).

G. Corrosion Protection: All helical pile materials shall be hot-dip galvanized in accordance with the requirements of ASTM A123, Grade 100.

PART 3 EXECUTION

3.01 ERECTION

A. General: The Subcontractor shall verify that all helical piles may be installed in accordance with all pertinent codes and regulations regarding such items as underground obstructions, right-of-way limitations, utilities, etc.

B. Installation Equipment:

1. Shall be rotary type, hydraulic power driven torque motor with clockwise and counter-clockwise rotation capabilities. The torque motor shall be capable of continuous adjustment to revolutions per minute (rpm) during installation. Percussion drilling equipment shall not be permitted. The torque motor shall have torque capacity 15 percent greater than the torsional strength rating of the central steel shaft to be installed.

2. Equipment shall be capable of applying adequate down pressure (crowd) and torque simultaneously to suit project soil conditions and load requirements. The equipment shall be capable of continuous position adjustment to maintain proper helical pile alignment.
C. Installation Tooling:

1. Shall consist of a Kelly Bar Adapter (KBA) and Type SS drive tool as manufactured by the helical pile manufacturer and used in accordance with the manufacturers written installation instructions.

2. A torque indicator shall be used during helical pile installation. The torque indicator can be an integral part of the installation equipment or externally mounted in-line with the installation tooling.
   a. Shall be capable of providing continuous measurement of applied torque throughout the installation.
   b. Shall be capable of torque measurements in increments of at least 500 foot pounds.
   c. Shall be calibrated prior to preproduction testing or start of work. Torque indicators which are an integral part of the installation equipment shall be calibrated onsite. Torque indicators which are mounted in-line with the installation tooling shall be calibrated either onsite or at an appropriately equipped test facility. Indicators that measure torque as a function of hydraulic pressure shall be calibrated at normal operating temperatures.
   d. Shall be recalibrated, if in the opinion of the Engineer and/or Subcontractor reasonable doubt exists as to the accuracy of the torque measurements.

D. Installation Procedures:

1. Central Steel Shaft:
   a. The helical pile installation technique shall be such that it is consistent with the geotechnical, logistical, environmental, and load carrying conditions of the Project.
   b. The lead section shall be positioned at the location as shown on the working drawings. The lead section may be started perpendicular to the soil face to assist initial advancement into the soil. After initial penetration, the required inclination angle shall be established. The helical pile sections shall be engaged and advanced into the soil in a smooth, continuous manner at a rate of rotation of 5 rpm to 20 rpm. Extension sections shall be provided to obtain the required minimum overall length and installation torque as shown on the working drawings. Connect sections together using coupling bolt and nut torqued to 40-foot pounds.
   c. Sufficient down pressure shall be applied to uniformly advance the helical pile sections approximately 3 inches per revolution. The rate of rotation and magnitude of down pressure shall be adjusted for different soil conditions and depths.
2. Termination Criteria:
   a. The torque as measured during the installation shall not exceed the torsional strength rating of the central steel shaft.
   b. Minimum embedment of 5 feet into the stiff young siltstone layer has been achieved, and bottom plate is bearing at elevation minus 15 feet (EL -15 feet) or deeper.
   c. The minimum installation torque and minimum embedment criteria as shown on the working drawings shall be satisfied prior to terminating the helical pile installation. In the event any helical pile fails these production quality control criteria, the following prequalified remedies are authorized:
      1) If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to achieving the minimum free-length required, the Subcontractor shall have the following options:
         a) Terminate the installation at the depth obtained subject to the review and acceptance of the Engineer, or;
         b) Replace the existing helical pile with one having a shaft with a higher torque strength rating. The new shaft size/type shall be subject to review and acceptance of the Engineer. If re-installing in the same location, the helix of the new helical pile shall be terminated at least 3 feet beyond the terminating depth of the original pile without exceeding any applicable maximum embedment length requirements.
      2) If the helical pile is refused or deflected by a subsurface obstruction, the installation shall be terminated and the pile removed. The obstruction shall be removed, if feasible, and the helical pile re-installed. If obstruction can’t be removed, the helical pile shall be installed at an adjacent location, subject to review and acceptance of the Engineer.
      3) If the torsional strength rating of the central steel shaft and/or installation equipment has been reached prior to proper positioning of the last plain extension section relative to the pile, the Subcontractor may remove the last plain extension and replace it with a shorter length extension. If it is not feasible to remove the last plain extension, the Subcontractor may cut said extension to the correct length and field drill a hole in cut-off shaft. The Subcontractor shall not reverse (back-out) the helical pile to facilitate extension removal.
4) The average torque for the last three feet of penetration shall be used as the basis of comparison with the minimum installation torque as shown on the working drawings. The average torque shall be defined as the average of the last three readings recorded at 1-foot intervals.

3.02 HELICAL PILE LOAD TESTS

A. Given the intended use of the helical piles for axial compression and the low number of piles proposed, no performance tests or proof tests intended for this project.

END OF SECTION
SECTION 32 11 23
AGGREGATE BASE AND SURFACING COURSES

PART 1 GENERAL

1.01 REQUIREMENTS

A. All aggregate material proposed for granular fill for the project shall be sourced from a quarry that meets the requirements in Section 00715.10 of the Standard Specifications. This includes requirements for fractured faces, unit weight of aggregate, soundness, durability, and the presence of harmful substances.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. T 19, Standard Method of Test for Bulk Density and Voids in Aggregate.
   c. T 104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
   d. T 113, Standard Method of Test for Lightweight Particles in Aggregate.
   e. T 335, Standard Method of Test for Determining the Percentage of Fracture in Coarse Aggregate.

2. ASTM International (ASTM):
   a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   f. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (2700 kN-m/m³)).
g. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.


m. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

n. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.

o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

3. Oregon Department of Transportation (ODOT) Test Methods:

a. TM 208, Oregon Air Aggregate Degradation.

b. TM 225, Presence of Wood Waste in Produced Aggregates.

c. TM 227, Evaluating Cleanness of Cover Coat Material.

d. TM 229, Determination of Elongated Material in Coarse Aggregates.

1.03 DEFINITIONS

A. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

B. Completed Lift: Compacted with uniform cross-section thickness.

C. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.

E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

G. Subbase Course: Sandy, gravelly material placed and compacted on prepared subgrade.

1.04 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials:
   a. Submit copies from commercial testing laboratory 20 days prior to delivery of materials to Project showing materials meeting the physical qualities specified, including:
      1) Gradation.
      2) Fractured Faces per AASHTO T 335.
      3) Unit weight of aggregate per AASHTO T 19.
      4) Soundness of aggregate per AASHTO T 104.
      5) Durability of aggregate per AASHTO T 96 and ODOT TM 208.
      6) Harmful substances within aggregate per AASHTO T 113 and ODOT TM 225, TM 227 and TM 229.

2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 BASE COURSE

A. As specified for 1-1/2-inch-0 Dense-Graded Aggregate in Section 02630 of the Standard Specifications.

B. Clean, hard durable pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

2.02 SURFACING COURSE

A. As specified for Dense Graded Base Aggregate, 3/4-inch-0, in Section 02630 of the Standard Specifications.

B. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring free or as coating on stone.

2.03 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.
B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Engineer’s acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. In accordance with Section 00641 of the Standard Specifications.

B. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. In accordance with Section 00641 of the Standard Specifications.

B. Hauling Materials:
   1. Do not haul over surfacing in process of construction.
   2. Loads: Of uniform capacity.
   3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

C. Spreading Materials:
   1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
   2. Produce even distribution of material upon roadway or prepared surface without segregation.
   3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.
3.04 CONSTRUCTION OF COURSES

A. Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown on Drawings.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate does not compact readily because of lack of fines or natural cementing properties, as follows:
   a. Spread evenly on top of base course, using spreader boxes or chip spreaders.
   b. Roll surface until keystone is worked into interstices of base course without excessive displacement.
   c. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

B. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown on Drawings.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of base after spreading operations and continue until density of a minimum 95 percent relative compaction has been achieved as determined by ASTM D1557.

B. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

C. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water to moisture condition as needed to obtain specified densities.

E. Place and compact each lift to the required density before succeeding lift is placed.

F. Remove floating or loose stone from surface of preceding course before placing leveling course.
G. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

H. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base and Leveling Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 FIELD QUALITY CONTROL

A. In-Place Density Tests:
   1. Provide testing laboratory at least 48 hours advance notification prior to testing.
   2. Show proof that areas meet specified requirements before identifying density test locations.
   3. Refer to Table 1 for minimum sampling and testing requirements for aggregate base course and surfacing.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Frequency</th>
<th>Sampling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation</td>
<td>ASTM C117 and ASTM C183</td>
<td>One sample every 500 tons but at least every 4 hours of production</td>
<td>Roadbed after processing</td>
</tr>
<tr>
<td>Moisture Density (Maximum Density)</td>
<td>ASTM D1557, Method D</td>
<td>One test for every aggregate grading produced</td>
<td>Production output or stockpile</td>
</tr>
</tbody>
</table>
Table 1
Minimum Sampling and Testing Requirements

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Frequency</th>
<th>Sampling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>In-Place Density and Moisture</td>
<td>ASTM D5195, ASTM D6938, and</td>
<td>One for each 500 ton but at least every</td>
<td>In-place completed, compacted area</td>
</tr>
<tr>
<td>Content</td>
<td>ASTM D2216 for moisture</td>
<td>10,000 sq. ft. of area</td>
<td></td>
</tr>
<tr>
<td></td>
<td>content</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.08 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
   i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
   l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
   m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
   n. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
   o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.

2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.

3. ASTM International (ASTM):
   c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures.
   e. D2489, Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures.
   g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.

C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.

D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.

E. Reclaimed asphalt pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.
F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.


H. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

1.03 SUBMITTALS

A. Informational Submittals:

1. Asphalt Concrete Mix Formula:
   a. Submit minimum of 15 days prior to start of production.
   b. Submittal to include the following information:
      1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate as specified in Section 00744.12 of the Standard Specifications.
      2) Bulk specific gravity for each aggregate constituent.
      3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
      4) Job mix formula properties demonstrating conformance with the mix requirements specified in Section 00744.13 of the Standard Specifications.
      5) Properties as stated in Section 00744 of the Standard Specifications, for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
      6) Percent of asphalt lost due to absorption by aggregate.
      7) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
      8) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
      9) Optimum mixing temperature.
     10) Optimum compaction temperature.
     11) Temperature-viscosity curve of asphalt cement to be used.
     12) Brand name of any additive to be used and percentage added to mixture.
2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for the following materials:
   a. Aggregate: Gradation, source test results as defined in Section 00744.12 of the Standard Specifications.
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Tack Coat: Type and grade of asphalt.
   d. Additives.
   e. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.
   d. Field density.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329 REV A.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F (10 degrees C) or air temperature is lower than 40 degrees F (4 degrees C). Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.
PART 2 PRODUCTS

2.01 MATERIALS

A. Tack Coat:

1. Emulsified Asphalt for Tack Coat or Seal Coat: Grade CSS-1, CSS-1h conforming to AASHTO M208 and Section 00730 of the Standard Specifications.

B. Sand for Blotter Material or Sand Seal: Clean, dry, with 100 percent passing No. 4 (4.75-millimeter) sieve, and a maximum of 10 percent passing No. 200 (75 m) sieve.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Engineer.

2. Source Changes:
   a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
   b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Engineer to confirm that properties are in compliance with design criteria.
   c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Asphalt Concrete: Level 3, 1/2-inch Dense Graded Asphalt Concrete Pavement (ACP) as specified in Section 00744 of the Standard Specifications.

C. Composition: Hot-plant mix of aggregate, mineral filler if required, and paving grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

D. Aggregate:

1. General: As specified in Section 00744.10 of the Standard Specifications; RAP material may be used up to a maximum of 30 percent by total weight as specified in the Standard Specification.

E. Mineral Filler: In accordance with AASHTO M17.
F. Asphalt Cement: Paving Grade PG 64-22 as specified in Section 00744.11 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:
   1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
   2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 APPLICATION EQUIPMENT

A. In accordance with Section 00744 of the Standard Specifications.

3.04 PREPARATION

A. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Existing Roadway:
   1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
   2. Remove existing material to a minimum depth of 1 inch (25 millimeters).
   3. Paint edges of meet line with tack coat prior to placing new pavement.

C. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.
3.05 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with Section 00744 of the Standard Specifications.

B. Tack Coat:

1. Prepare material, as specified in Section 00730 of the Standard Specifications, prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
3. Do not apply more tack coat than necessary for the day’s paving operation.
4. Touch up missed or lightly coated surfaces and remove excess material.
5. Application Rate: 0.05 gallon per square yard to 0.20 gallon per square yard (0.25 liter per square meter to 0.95 liter per square meter) of asphalt (residual if diluted emulsified asphalt).

C. Pavement Mix:

1. Prior to Paving:
   a. Sweep surface free of dirt, dust, or other foreign matter.
   b. Patch holes in surface with asphalt concrete pavement mix.
2. Place asphalt concrete pavement mix in two equal lifts.
3. Compacted Lift Thickness:
   a. Minimum: Twice maximum aggregate size, but in no case less than 2 inch (25 millimeters).
   b. Maximum: 3 inches (100 millimeters).
4. Total Compacted Thickness: As shown.
5. Sequence placement so that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
   a. Offset edge of each layer a minimum of 6 inches (150 millimeters) so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day’s run to expose full vertical depth of layer.
8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches (150 millimeters) on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

D. Compaction:

1. Roll until roller marks are eliminated and density of 92 percent of measured maximum density determined in accordance with ASTM D2041 is obtained.

2. Joint Compaction:
   a. Place top or wearing layer as continuously as possible.
   b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
   c. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
   d. Cut away waste material and lay new mix against fresh cut.

E. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.

2. Completed Surface or Wearing Layer Smoothness:
   a. Uniform texture, smooth, and uniform to crown and grade.
   b. Maximum Deviation: 1/8 inch (3 millimeter) from lower edge of a 12-foot (3.6-meter) straightedge, measured continuously parallel and at right angle to centerline.
   c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.

3. Transverse Slope Maximum Deviation: 1/4 inch (6 millimeters) in 12 feet (3.6 meters) from rate of slope shown.

4. Finished Grade:
   a. Perform field differential level survey on maximum 50-foot (15-meter) grid and along grade breaks.
   b. Maximum Deviation: 0.02 foot (6 millimeters) from grade shown.

3.06 PAVEMENT INLAY

A. Preparation:

1. Conduct pavement milling work as specified and as shown in Drawings.

2. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.

4. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
5. Portland Cement Concrete Joints: Remove joint filler to minimum 1/2 inch (12 millimeters) below surface.

B. Application:

1. Tack Coat: As specified in this section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.
3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.
4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches (50 millimeters).
5. Actual compacted thickness of intermittent areas of 120 square yards (100 square meters) or less may exceed 2 inches (50 millimeters), but not 4 inches (100 millimeters).
6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.07 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 3 inches (75 millimeters) or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch (350 Newtons per linear centimeter to 525 Newtons per linear centimeter). Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.

3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch (6 millimeters) or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.08 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T166.
2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons (400 mg) of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice’s) Specific Gravity: Once every 1,000 tons (900 mg) or once every 8 hours, whichever is greater.
2. Density Tests: Once every 500 tons (450 mg) of mix or once every 4 hours, whichever is greater.

END OF SECTION
PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in.) Drop.
3. ASTM International (ASTM):
   c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

1.02 SUBMITTALS

A. Action Submittals:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Informational Submittals:

1. Curing Compound: Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

1.03 QUALITY ASSURANCE

PART 2 PRODUCTS

2.01 MATERIALS
   A. Conform to Section 00759 of the Standard Specification.

2.02 EXPANSION JOINT FILLER
   A. Preformed asphalt-impregnated, expansion joint material meeting ASTM D994, 1/2-inch thick.

2.03 CONCRETE
   A. Ready-mixed meeting ASTM C94, Option A, with compressive strength of 3,500 psi at 28 days. As specified in Section 03 30 00, Cast-in-Place Concrete.
   B. Maximum Aggregate Size: 1-1/2 inch.
   C. Slump: 2 inches to 4 inches.

2.04 CURING COMPOUND
   A. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Perform Work in accordance with the referenced Standard Specification.

3.02 FORMWORK
   A. Lumber Materials:
      1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.
      2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.
   B. Metals: Steel in new undamaged condition.
   C. Setting Forms:
      1. Construct forms to shape, lines, grades, and dimensions.
      2. Stake securely in place.
D. Bracing:
   1. Brace forms to prevent change of shape or movement resulting from placement.
   2. Construct short-radius curved forms to exact radius.

E. Tolerances:
   1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.
   2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.03 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.04 CURB CONSTRUCTION

A. Construct ramps at pedestrian crossings.

B. Expansion Joints: Place at maximum 45-foot intervals at the beginning and end of curved portions of curb, and at connections to existing curbs. Install expansion joint filler at each joint.

C. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.

D. Contraction Joints:
   1. Maximum 15-foot intervals in curb.
   2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
   3. Insert steel sheet to full depth of curb.
   4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
   5. Finish top of curb with steel trowel and finish edges with steel edging tool.
E. Front Face:
   1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
   2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.
   3. Remove and replace defective concrete.
   4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
   5. Continue curing for minimum of 5 days.

F. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.
   1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
   2. Compact backfill firmly.

3.05 SIDEWALK CONSTRUCTION

A. Thickness:
   1. 4 inches in walk areas.
   2. 6 inches in driveway areas.

B. Connection to Existing Sidewalk:
   1. Remove old concrete back to an existing contraction joint.
   2. Clean the surface.
   3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

D. Contraction Joints:
   1. Provide transversely to walks at locations opposite contraction joints in curb.
   3. Construct straight and at right angles to surface of walk.
E. Finish:

1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
3. Apply curing compound to exposed surfaces upon completion of finishing.
4. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION
SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):


3. Federal Specifications (FS):
   b. TT-B-1325C, Beads (Glass Spheres); Retroreflective.

1.02 DEFINITIONS


1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Paint.
      2) Thermoplastic material.
      3) Reflective markers.
      4) Epoxies, resins, and primers to be used.
B. Informational Submittals:

1. Description of proposed methods for removal of drips, overspray, improper markings, paint and thermoplastic material tracked by traffic, and existing markings.
2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for products specified in this section.
3. Manufacturer’s Instructions:
   a. Application of preformed tape.
   b. Application of glass beads.
   c. Application of epoxy resin.
   d. Installation of reflective markers.

PART 2 PRODUCTS

2.01 GENERAL
A. All products shall be in accordance with Section 00850 of the Standard Specifications.

2.02 PAINT
A. Color: White or yellow.
B. Traffic paint in accordance with Section 00860 of the Standard Specifications.
C. Homogeneous, easily stirred to smooth consistency, with no hard settlement or other objectionable characteristics during storage period of 6 months.

2.03 THERMOPLASTIC MARKING
A. Color: White or yellow.
B. In accordance with Section 00865 of the Standard Specifications.

2.04 RAISED REFLECTIVE MARKERS
A. Type I meeting requirements of Section 00855 of the Standard Specifications.
B. Metallic or nonmetallic, or prismatic reflector type, of permanent colors retaining color and brightness under action of traffic.
C. Rounded surfaces presenting a smooth contour to traffic.
D. Epoxy in accordance with AASHTO M237.
2.05 GLASS BEADS
   A. In accordance with Section 00225 of the Standard Specifications.

PART 3 EXECUTION

3.01 GENERAL
   A. Surface Preparation, Application, and Protection: In accordance with Section 850 of the Standard Specifications.

3.02 SURFACE PREPARATION
   A. Cleaning:
      1. Thoroughly clean surfaces to be marked before application of pavement marking material.
      2. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods.
      3. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion.
      4. Scrub areas of old pavement affected with oil or grease with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application.
      5. Surfaces shall be completely free of dirt and ice, and dry of water at the time of application of materials specified herein.
      6. Oil-Soaked Areas: After cleaning, seal with cut shellac to prevent bleeding through the new paint.
      7. Reclean surfaces when the Work has been stopped due to rain.
      8. Existing Pavement Markings:
         a. Remove existing pavement markings that may interfere or conflict with newly applied marking patterns, or that may result in a misleading or confusing traffic pattern.
         b. Do not apply thermoplastic markings over existing preformed or thermoplastic markings.
         c. Perform grinding, scraping, sandblasting or other operations so finished pavement surface is not damaged.
   B. New Asphalt Pavement: Allow a minimum pavement cure time of 30 days before applying paint.
3.03 PAINT APPLICATION

A. General:
   1. Thoroughly mix pigment and vehicle together prior to application, and keep thoroughly agitated during application.
   2. Do not add thinner.
   3. Apply only when air and pavement temperatures are above 40 degrees F and less than 95 degrees F. Maintain paint temperature within these same limits.
   4. Apply only when surface is dry.
   5. Do not apply when conditions are windy to the point of causing overspray or fuzzy line edges.
   6. Provide guidelines and templates to control paint application.
   7. Take special precautions in marking numbers, letters, and symbols.
   8.Sharply outline edges of markings and apply without running or spattering.

B. Rate of Application:
   1. Reflective Markings: Apply evenly, 105 plus or minus 5 square feet per gallon.
   2. Glass Bead Application:
      a. Apply immediately following application of paint.
      b. Use evenly distributed drop-on application method.
      c. Rate: 6 pounds per gallon of paint.
   3. Nonreflective Markings: Apply paint evenly to pavement surface at a rate of 105 plus or minus 5 square feet per gallon.
   4. On new pavement or new asphalt surface treatments, apply two coats of paint at a uniform rate of 210 square feet per gallon.

C. Drying:
   1. Provide maximum drying time to prevent undue softening of bitumen and pickup, displacement, or discoloration by traffic.
   2. If drying is abnormally slow, discontinue painting operations until cause is determined and corrected.

D. Protection:
   1. Protect markings from traffic until paint is thoroughly dry.
   2. Protect surfaces from disfiguration by paint spatters, splashes, spills, or drips.
E. Cleanup: Remove paint spatters, splashes, spills, or drips from the Work and staging areas including areas outside the immediate Work area where spills occur.

3.04 THERMOPLASTIC MARKING APPLICATION

A. Following specified surface preparation, prime and apply marking and glass beads to provide a reflectorized strip as shown on Drawings.

B. Application Temperatures:
   1. Pavement Surface: Minimum 40 degrees F and rising.
   2. Thermoplastic: Minimum 375 degrees F, maximum 425 degrees F.

C. Primer:
   1. On existing asphalt pavements, apply epoxy resin primer/sealer according to thermoplastic manufacturer’s recommendations.
   2. Allow primer/sealer to dry prior to applying thermoplastic.

D. Thermoplastic Marking:
   1. Extrude or spray in a molten state, free of dirt or tint at a minimum thickness of 0.125 inch; maximum thickness of 0.190 inch.
   2. Apply centerline, skipline, edgeline, and other longitudinal type markings with a mobile applicator.
   3. Apply special markings, crosswalks, stop bars, legends, arrows, and similar patterns with a portable, extrusion-type applicator.

E. Glass Bead Application:
   1. Immediately after marker application, mechanically apply such that the beads are held by and imbedded in the surface of the molten material.
   2. Application Rate: 1 pound per 20 square feet of compound.

F. Cool completed marking to ambient temperature prior to allowing vehicular traffic.

3.05 INSTALLATION OF RAISED REFLECTIVE MARKERS

A. Apply epoxy to cleaned and prepared pavement area per manufacturer’s instructions.

B. Apply marker to epoxy before epoxy has a chance to set.
PHASE IV BEAVER CREEK WATER SUPPLY

C. Align markers carefully, projecting no more than 3/4 inch above level of pavement.

D. Spacing:
   1. Solid Longitudinal Lines: Match existing in accordance with Lincoln County Standards.
   2. Broken Centerlines: Match existing in accordance with Lincoln County Standards.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
x. F1911, Standard Practice for Installation of Barbed Tape.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.02 DEFINITIONS

A. Terms as defined in ASTM F552.

1.03 AMERICAN IRON AND STEEL REQUIREMENT

A. All iron and steel products must be produced in the United States per the American Iron and Steel (AIS) requirements mandated by Section 746 of Title VII of the Consolidated Appropriations Act of 2017 and subsequent statutes mandating domestic preference. Refer to USDA Rural Utilities Service (RUS) Bulletin 1780-35 for requirements, applicability, and exceptions.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences and gates.
      1) Fence, gate posts, rails, and fittings.
      2) Chain link fabric.
      3) Gates and hardware.
      4) Gate operators, motors, and mounting arrangements, switches, and controls; include operating instructions.
5) Gate access system, including access control features, power and control wiring diagrams, and operating instructions for all components of the complete system.
   a) Power and control wiring diagrams to include customer interface with terminal block numbers.
6) Motor data per Section 26 20 00, Low-Voltage AC Induction Motors.
7) Accessories: Barbed wire.

2. Test Reports: Field test result for compliance of installation of chain link fence, gates, and gate operators.

B. Informational Submittals:
   1. Manufacturer’s recommended installation instructions.
   2. Evidence of Supplier and installer qualifications.
   3. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Automatic Gate Operator System Supplier: 5 years’ experience in gate operator systems.
   2. Automatic Gate Operator System Installer: Experienced installer who has completed chain link fences and gates similar in material, design, and extent to those indicated for Project and whose work has resulted with a record of successful in-service performance with a minimum 3 years’ experience.

B. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

C. Preinstallation Conference: Conduct conference at project Site with gate installer to verify layout and operations of automatic gate operating system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.07 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence and gates.
B. Interruption of Existing Utility Service: Notify owner of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

1.08 SPECIAL GUARANTEE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of the Owner, removal and replacement of the following items found defective during a period of 5 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in the General Conditions.

1. Faulty operations of gate operators and controls.
2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components.

2.02 CHAIN LINK FENCE FABRIC

A. Galvanized fabric conforming to ASTM A392, Type II, Class 1, 1.2 ounces per square foot.

B. Provide PVC-coated or polymer-coated galvanized fabric conforming to ASTM F668, Class 1 or Class 2a over metallic-coated steel wire for 42-inch high fence.


C. Fabric Height: 42 inches and 96 inches as shown on Drawings.

D. Core Wire Gauge: No. 9.

E. Pattern: 2-inch diamond-mesh.

F. Diamond Count: Manufacturer’s standard and consistent for fabric furnished of same height.
G. Loops of Knuckled Selvages Located along top and bottom of 42-inch-high Fence and along bottom of 96-inch-high Fence: Closed or nearly closed with space not exceeding diameter of wire.

H. Wires of Twisted Selvages Located along top of 96-inch-high Fence:
   1. Twisted in a closed helix three full turns.
   2. Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.

2.03 POSTS

A. General:
   1. Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence, except as modified in this section.
   2. Round Steel Pipe, Schedule 40: ASTM F1083 High Strength Grade (50 ksi yield).
   3. Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
   4. Lengths: Manufacturer’s standard with allowance for minimum embedment below finished grade as shown on Drawings.
   5. Protective Coatings:
      a. Zinc Coating: ASTM F1043, Type A external and internal coating.

B. Line Posts:
   1. Round Steel Pipe:
      a. Outside Diameter: 2.375 inches.
      b. Weight: 3.65 pounds per foot.

C. End, Corner, Angle, and Pull Posts:
   1. Round Steel Pipe:
      a. Outside Diameter: 2.875 inches.
      b. Weight: 5.79 pounds per foot.

D. Posts for Swing Gates 8 Feet High and Under:
   1. ASTM F900.
   2. Round Steel Pipe:
      a. Outside Diameter: 4 inches.
      b. Weight: 6.56 pounds per foot.
2.04 TOP AND BRACE RAILS

A. Galvanized Round Steel Pipe:
   1. ASTM F1083.
   2. Outside Diameter: 1.66 inches.
   3. Weight: 2.27 pounds per foot.

B. Protective Coatings: As specified for posts.

C. Color Coating: ASTM F1043, minimum 10-mil thickness over zinc coating to match color of chain link fabric.

D. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy industrial fence.

2.05 FENCE FITTINGS

A. General: In conformance with ASTM F626, except as modified by this article.

B. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

C. Tension and Brace Bands: No exceptions to ASTM F626.

D. Tension Bars:
   1. One-piece.
   2. Length not less than 2 inches shorter than full height of chain link fabric.
   3. Provide one bar for each gate and end post, and two for each corner and pull post.

E. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

F. Tie Wires, Clips, and Fasteners: According to ASTM F626.

G. Barbed Wire Supporting Arms: Pressed steel or cast iron with clips, slots, or other means for attaching strands of barbed wire integral with post cap for each post, with single 45-degree arms for supporting three strands of barbed wire. Arms shall withstand 250 pounds of downward pull at outermost ends of the arms without failure.
2.06 TENSION WIRE

A. Zinc-coated steel marcelled tension wire conforming to ASTM A824, Type II, Class 2.

2.07 BARBED WIRE

A. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade.

1. Line Wire: Two strands of No. 12-1/2 gauge.
2. Barbs:
   a. Number of Points: Four.
   b. Length: 3/8 inch minimum.
   c. Shape: Round.
   d. Diameter: No. 14 gauge.
   e. Spacing: 5 inches.

2.08 GATES

A. General:

1. Gate Operation: Opened and closed easily by one person.
3. Frames and Bracing: Fabricate members from round galvanized steel tubing with outside dimension and weight according to ASTM F900.
4. Gate leaves more than 8 feet wide shall have intermediate tubular members and diagonal truss rods to provide rigid construction, free from sag or twist.
5. Gate Fabric Height: Same as for adjacent fence height.
7. Chain Link Fabric: Attached securely to gate frame at intervals not exceeding 15 inches.
8. Gate Posts and Frame Members: Extend gateposts and frame end members above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
9. Latches: Arranged for padlocking so padlock will be accessible from both sides of gate.

B. Swing Gates: Comply with ASTM F900 for double swing gate types.

1. Leaf Width: As shown.
2. Hinges: Offset type, malleable iron.
   a. Furnished with large bearing surfaces for clamping in position.
b. Designed to swing either 180 degrees outward, 180 degrees inward, or 90 degrees in or out, as shown, and not twist or turn under action of gate.

3. Latches: Forked latch for pedestrian gate. Latch for double swing gate to be designed for automated operation of the gate.

4. Gate Stops: Mushroom type or flush plate with anchors, suitable for setting in concrete.

5. Locking Device and Padlock Eyes: Integral part of latch, requiring one padlock for locking both leaves of double gate.

6. Hold-Open Keepers: Designed to automatically engage gate leaf and hold it in open position until manually released.

2.09 GATE OPERATOR SYSTEM

A. General: Provide factory-assembled automatic operating system designed for gate size, type, weight, and operation frequency. Provide operation control system with characteristics suitable for Project conditions, safety devices, and weatherproof enclosures; coordinate electrical requirements with Division 26, Electrical.

1. Provide operator designed so motor may be removed without disturbing limit-switch adjustment and without affecting auxiliary emergency operator.

2. Provide operator with UL approved components.


4. Provide unit designed and wired for both right-hand/left-hand opening, permitting universal installation.

B. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor.

C. Gate Operator:

1. Heavy-duty, high frequency, electrical models designed to open and close gates provided.

2. For each gate, supply manufacturer of gate operator with complete details of gate, hardware, track rollers, adjacent fence posts, and fence construction for development and detailing of gate operator.

3. Furnish with following features:
   a. Metal enclosure, including attachments shall be constructed with finish and design suitable for exterior installation in all-weather environment.
b. Minimum 1/2-hp motor, 208V ac, three-phase, 60-Hz electric power, reversible.
c. Electric motor driven hydraulic power pack with hard rubber wheels in contact with operating type secured to gate. Transmission of opening or closing forces to gate shall be by rotation of wheels against operating type.
d. Positive limit switch, to sense position of gate and provide control to prevent damage to gate operator.
e. NEMA 250, Type 12 enclosure for motor control components.
g. 24V dc control circuit to power remote control gate activation devices.
h. Manual operation feature or disconnect, without use of tools, for easy operation during power failure, malfunction, or emergency.
i. Aluminum drive rail designed for attachment to sliding gate in manner that reinforces gate assembly.
j. Gate Travel Speed:
   1) Minimum 1 foot per second.
   2) Speed adjusting feature that provides range of appropriate speeds for slide gate operation is acceptable but not required.
   3) Maximum Gate Leaf Weight: 2,000 pounds.
   4) Frequency of Use: Continuous duty.
   5) Equipped with manual release.
k. Compatible with gate operator control devices provided.

4. Manufacturers:
a. Hy-Security Gate Operator, Seattle, WA.
b. Automated Equipment Co., Seattle, WA.
c. Stanley.
d. Richards Wilcox, Aurora, IL.

D. Access System:

1. Remote gate operator transmitter to activate gate operator.
2. For vehicular protection, provide loop detectors minimum of 4 feet away from each side of gate.
3. Provide motorized gate with automatic safety sensors in accordance with UL 325. Activation of sensor(s) shall cause gate operator to immediately reverse gate in both opening and closing cycles and hold until clear of obstruction.
4. The following safety sensor devices shall be provided and connected to the gate operator system:
   a. Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
b. Photo Eyes:
   1) Photo eyes shall be through-beam type.
   2) Hoods shall be required for photo eyes.
   3) Provide EMX Industries, Inc., Cleveland, OH; IRB-325 Infra-red Photocell, “or-equal.”

c. Edge Sensors:
   1) Provide MillerEdge, West Grove, PA; Sensing Edge, “or-equal.”
   2) Coordinate with edge sensor manufacturer for sensor model.

5. Gate Operation:
   a. Entry: Gate opens when activated by valid remote gate operator transmitter. Gate closes after adjustable time period up to 90 seconds.
   b. Exit: Gate opens when activated by remote gate operator transmitter. Gate closes as for entry.
   c. Override or 7-day timer to allow gate to remain open for up to 12 hours with equipment at rest.
   d. Gate remains open while vehicles are detected by the loop detectors.

6. Manufacturers:
   a. Hy-Security Gate Operator, Seattle, WA.
   b. Power Door Engineering, Seattle, WA.
   c. Quentin Control Systems, NW, Inc., Seattle, WA.
   d. Continental Instruments Corp., Westbury, NY.
   e. Richards Wilcox, Aurora, IL.

2.10 CONCRETE

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete, for Class 4000F0S1P0C1.

2.11 FENCE GROUNDING

A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
   1. Material Above Finished Grade: Copper.
   2. Material On or Below Finished Grade: Copper.

B. Connectors and Grounding Rods: Comply with UL 467.
   1. Connectors for Below Grade Use: Exothermic welded type.
   2. Grounding Rods: Copper-clad steel.
PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences and gates in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer’s recommendations, as approved by Engineer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for a complete fence and gate installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

D. Drainage Crossings: Where the chain-link fence must cross drainage ditches or swales, the main fence shall be carried across a ditch or swale with additional fence added below.

1. Frames and Bracing: The fence added below shall be fabricated with galvanized round steel pipe conforming to the requirements for top and brace rails.

2. The construction of the frame shall be welded or assembled with corner fittings. The frame shall be rigid and to the extent necessary to maintain a 2-inch clearance between bottom of the frame and finish grade. If necessary to maintain rigidity, attach to the frame a series of 3/8-inch diameter galvanized steel pipe stakes that are embedded a minimum of 2 feet to the sides and bottom of the ditch.

3. Attach chain link fabric securely to frame at intervals not exceeding 12 inches.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

C. Embedment Coating: Coat portion of galvanized or aluminum-coated steel posts that will be embedded in concrete as specified in Section 09 90 00, Painting and Coating. Extend coating 1 inch above top of concrete.
3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly between terminal end, corner, and gate posts. Do not exceed maximum spacing shown on Drawings.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into
rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.08 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.


C. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

D. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.

E. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.

F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.
3.09 BARBED WIRE
A. Install barbed wire uniformly in configurations of three strands of barbed wire on supporting arms. Pull wire taut and install securely to supporting arms and secure to end terminal post or terminal arms.

3.10 GATES
A. Install gates according to manufacturer’s written instructions, level, plumb and secure for full opening without interference. Attach fabric and hardware to gate using tamper-resistant or concealed means. Adjust hardware for smooth operation and lubricate where necessary so gates operate satisfactorily from open or closed position.
B. Set gate stops in concrete to engage center drop rod or plunger bar.

3.11 GATE OPERATOR SYSTEMS
A. Install gate operator systems in accordance with manufacturer’s recommendations, aligned and true to fence line and grade.
B. Furnish with equipment and accessories necessary for complete installation.
C. Hand excavate holes for pads in firm undisturbed soil to dimensions, depths, and locations as required by gate operator component manufacturer’s written instructions and as shown on Drawings.
D. Vehicle Loop Detector System: Install loop detectors in gravel road according to manufacturer’s written instructions. Connect to equipment operated by detector.
E. Safety Sensors:
1. Install photo eye on both the unsecured sides of the gate as shown on Drawings. Provide communication cables to photo eye components on both sides of road. Photo eye shall be installed according to manufacturer’s instructions and coordinated with Gate Operator Installation.
2. Install edge sensor on the bottom edge and leading edge of each gate leaf as shown on Drawings. Edge sensor shall be installed according to manufacturer’s instructions and coordinated with Gate Operator installation.
3.12 ELECTRICAL GROUNDING

A. Ground fences at a maximum interval of 1,000 feet in accordance with applicable requirements of IEEE C2, National Electrical Safety Code.

B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.

C. Grounding Method: At each grounding location, drive a grounding rod vertically until top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at grounding location.

3.13 FIELD QUALITY CONTROL


B. Gate Tests:

1. Prior to acceptance of installed gates, demonstrate proper operation of gates under each possible open and close condition specified.
2. Adjust gate to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range.
3. Confirm that latches and locks engage accurately and securely without forcing and binding.

C. Automatic Gate Operator:

1. Energize circuits to electrical equipment and devices.
2. Adjust operators, controls, safety devises, and limit switches.
3. Start units to confirm proper motor rotation and unit operation free of binding. Test and adjust all gate controls for proper operation.
4. Replace damaged and malfunctioning controls and equipment.
5. Lubricate hardware, gate operator and other moving parts.

3.14 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, to train Owner’s personnel to adjust, operate, and maintain gates.
3.15 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION
PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. This section includes gravity block retaining wall systems consisting of a column of segmental concrete facing units retaining compacted soil backfill and/or a native ground cut.

B. Work shall consist of furnishing all materials, labor, equipment, field supervision, and installing a gravity block wall system in accordance with given specifications.

C. All installations should conform to Drawings, profiles, and Specifications for this Project. Construction of the gravity block wall may involve removal and demolition of existing slope and landscaping as shown on Drawings. Work shall be conducted to minimize excavation into the existing slope.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):

2. ASTM International (ASTM):
   e. C805, Standard Test Method for Rebound Number of Hardened Concrete.

1.03 DEFINITIONS

A. Free-draining, well-graded, and coarse-grained aggregates placed immediately behind the blocks to relieve hydrostatic pressures or seepage forces and to prevent clogging of aggregate drainage medium if a geotextile fabric is not used.

B. Drainage Swale: A small depression adjacent to the top of wall to collect surface water run-off and discharge by gravity flow.

C. Drainage/Underdrain Pipe: Perforated pipe with adequate flow capacity placed typically at the base of the wall to discharge collected water into suitable receptacle by gravity flow.

D. Foreslope/Toeslope: Downslope in front of the toe of wall.

E. Foundation Subgrade: Competent native soil subgrade or compacted structural fill subgrade for supporting the gravity block wall structure as approved by a qualified Geotechnical Engineer.

F. Geotextile Filter Fabric: A filter fabric (with adequate permittivity or porosity) placed against the retained soil mass or between drainage media and retained soil mass to minimize clogging of drainage media.

G. Gravity Block Wall Unit: A segmental concrete unit with shear keys generally made of “surplus concrete mix” in the yard of a ready-mix concrete supplier.

H. Gravity Soil Mass: Compacted structural fill placed immediately behind the wall, which contributes to the gravity mass of the wall structure.

I. Leveling Pad: Densely compacted and free draining crushed rock pad for distributing the weight of block wall over a wider area and for providing a working surface during construction.

J. Relative Compaction: Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Engineer.

K. Retained Soil: Native soils or compacted granular fill situated immediately behind drainage fill. The primary function of the gravity wall is to retain this soil mass without failure.
L. Retained Backfill: Compacted granular fill placed behind the drainage fill or directly behind the gravity block wall units as outlined on Drawings.

1.04 SYSTEM DESCRIPTION

A. Design Requirements: Design the retaining wall system in accordance with the design guidelines presented by the manufacturer of the gravity block wall system. The designer of the gravity block wall system shall be certified and authorized by the manufacturer of the gravity block wall system and shall be a licensed Professional Engineer in the State of Oregon.

B. Performance Requirements: The contractors, material suppliers, and wall system suppliers shall have sufficient past project experience and shall be approved by the Engineer as part of submittal.

C. Wall Design Criteria and Parameters:

1. Design of the gravity block wall system shall be based on the criteria and geotechnical parameters specified below:
   a. Design calculations shall be based on the recommended procedure by manufacturer of the gravity block wall system. This procedure shall be based on the requirements specified in the 2015 IBC, current AASHTO Standard Specifications for Highway Bridges, including current interims and the National Concrete Masonry Association (NCMA) Design Manual for Segmental Retaining Walls. In the event of conflict, the most stringent of the design requirements shall be used.
   b. Factors of safety shall be as follows:
      1) Sliding: Greater than or equal to 1.5.
      2) Overturning: Greater than or equal to 2.0.
      3) Bearing Capacity: Greater than or equal to 2.0.
      4) Global Stability: Greater than or equal to 1.5.
   c. Geotechnical parameters for design shall be as follows:

<table>
<thead>
<tr>
<th>Soil Properties</th>
<th>Retained Soil</th>
<th>Foundation Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Weight (pcf)</td>
<td>125</td>
<td>120</td>
</tr>
<tr>
<td>Friction Angle (degrees)</td>
<td>34</td>
<td>32</td>
</tr>
<tr>
<td>Cohesion (psf)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

d. Allowable bearing pressure for the foundation shall be 3,000 psf (static) and 4,000 psf (seismic). Design for seismic loading shall be based on applicable criteria from the International Building Code (IBC), 2015.
e. For the segmental block wall at the Water Treatment Plant, operating weight of the generator with full fuel is 22,750 pounds. Contractor to account for this surcharge in wall design. Refer to Drawings for location behind wall.

f. For areas where no equipment or structural loads are applied, design should account for a surcharge behind the wall equivalent to a fill thickness of 2 feet.

1.05 SUBMITTALS

A. Submittals shall be made 15 days prior to the start of construction. In addition, the Contractor shall provide a list of successfully completed projects along with related Project references.

B. Product Data: Manufacturer’s materials specifications, installation instructions, and general recommendations.

C. Retaining Wall Plans: Engineering drawings, cross-sections, elevations, and large scale details of elevation, typical sections, details, and connections. Plans shall be stamped and signed by a qualified Professional Engineer licensed in the State of Oregon.

D. Quality Control and Certification Submittals: Design calculations and Drawings for the gravity block retaining wall system. All design data shall be stamped by the Designer. The designer shall be a qualified Professional Engineer licensed in the State of Oregon.

1.06 QUALITY ASSURANCE

A. Preconstruction Meeting: A meeting between the Geotechnical Engineer, wall designer, Contractor, material supplier, subcontractors, and the Owner shall be held at the Site in order to review the gravity block retaining wall design and construction requirements. A notification shall be sent to all the parties at least 3 days in advance of the time of the meeting.

1.07 DELIVERY, STORAGE, AND HANDLING

A. At the time of delivery, the Contractor shall inspect and confirm proper type and grade of materials. All product specifications shall be reviewed to assure that all specified materials have been delivered.

B. The Contractor shall store and handle all materials in accordance with manufacturer’s recommendations. The Contractor shall avoid excessive mud, wet concrete, epoxy, or other deleterious materials from coming in contact with and affixing to materials.
C. The Contractor shall discard all damaged materials and not use them in wall construction.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Manufacturer of the gravity block wall system shall be the following:


2.02 MATERIALS

A. Gravity Block Wall Segmental Unit:

1. The gravity block wall units shall have 28-day compressive strength of at least 4,000 psi.
2. All individual gravity block wall units shall be free of cracks and other defects that would interfere with the placement and locking of units. Specifically, all shear keys shall be free of any damage.

B. Drainage Fill: As specified for Granular Drain Material in Section 31 23 23.15, Trench Backfill.

C. Drainage Pipe: The drainage (underdrain) pipe shall be placed as shown on Drawings.

D. Retained Backfill Materials: Retained backfill materials shall consist of granular fill as specified in Section 31 23 23, Fill and Backfill.

E. Base Leveling Pad Material: Base leveling pad material shall consist of compacted crushed surfacing base course minimum 12 inches thick. Base course rock shall be in accordance with Section 31 23 23, Fill and Backfill.

F. Geogrid Reinforcement: Materials for geogrid reinforcement shall be as recommended by the wall manufacturer and installed as required by design and as specified in Section 31 32 19.16, Geotextile.

PART 3 EXECUTION

3.01 CONSTRUCTION REQUIREMENTS

A. General: The wall contractor and the Site Supervisor shall have successfully completed several projects including the installation of gravity block wall system described herein.
B. Excavation:

1. The Contractor shall provide adequate excavation support during construction in accordance with local, state, and federal safety regulations, and as specified in Section 31 23 16, Excavation, and Section 31 41 00, Shoring.
2. It shall be Contractor’s responsibility to assure site safety during excavation and other construction activities.
3. The subgrade shall be excavated to meet design requirements shown on grading plans and as specified in Section 31 23 13, Subgrade Preparation.
4. Excavations shall be made vertically to the plan elevation and horizontally so that over-excavation is minimized. Width of excavation should allow for wall base and underdrain pipe.
5. Start excavation at the lowest wall level. If wall steps up in one block height, the base block should be installed at the lowest level in order to establish grade and face location of the second level.
6. Overexcavated or filled areas shall be well compacted and inspected and approved by a qualified Geotechnical Engineer.

C. Foundation Preparation:

1. Foundation trench shall be excavated below the frost zone depth and allowance for placement of crushed surfacing base course and concrete leveling pad.
2. A qualified Geotechnical Engineer shall inspect and approve the reinforced zone and leveling pad foundation soil subgrade in order to ensure adequate bearing capacity. The Geotechnical Engineer may recommend additional testing of the foundation, depending on the nature of the material exposed at the subgrade during excavation. Subgrade soil areas not meeting required bearing strength shall be marked in the field and the Contractor shall remove and replace these areas with approved fill materials.
3. Foundation subgrade soils and any backfill materials shall be compacted to a minimum of 95 percent modified proctor maximum dry density and at moisture content within 2 percent of optimum, in accordance with ASTM D1557, before placing the leveling pad.

D. Leveling Pad Installation:

1. The leveling pad shall consist of 12 inches crushed surfacing base course compacted to 95 percent of ASTM D1557 (modified proctor compaction density).
2. A gravity block wall supplier’s representative experienced in the gravity block wall construction shall assist the Contractor regarding leveling pad preparation for achieving specified wall batter. The Engineer shall inspect and approve the leveling pad prior to the placement of blocks.

3. As a minimum, start at the lowest wall level, locate the front face of the wall, run a string about 1 inch in front and 2 inches above the base. Use 2 by 6 or 2 by 8 pieces of wood boards and steel stakes to make a form for achieving design batter. Set front board in line with the string and at base elevation of the wall. Locate and place the back board at a distance equal to the base width of the wall. Set elevation of back board so that design batter can be achieved. Without moving the string line, start leap-frogging the boards in line with the string and move forward along the length of the wall. It is best to prepare the entire leveling pad/base before placing the blocks.

E. Unit/Block Installation: A track-mounted excavator is the ideal equipment for block installation. A wire rigging with swivel hooks, OSHA approved and rated for weight of the blocks can be attached to the excavator and used for lifting, moving, and placing the blocks.

1. The Contractor shall carefully place the first course of gravity block wall units only after the leveling pad has been approved by the Engineer for adequate batter.

2. Block placement should start at the lowest elevation. At the start of the wall, make a line perpendicular to the face of the wall so the first block can be placed square to the wall face.

3. All gravity block wall units shall be placed snugly together (maximum 1/4-inch gap) and parallel to the straight or curved line of the wall face.

4. The gravity block wall units shall be installed free of all protrusions, debris before installing the next course of units.

5. Do not place any more than five to six blocks along the first course before starting on the second course.

6. At the completion of the placement of each course, a string line shall be pulled to confirm that the wall geometry is being maintained.

7. All battered wall corners shall be installed and locked per the block manufacturer’s recommendation as approved by the Engineer.

F. Drainage Fill and Drainage Pipe Placement:

1. The gravity block wall units do not require core fill since there are no voids.

2. The drainage fill shall be placed within an envelope of 12 inches behind the wall and shall consist of a free draining, coarse-grained granular materials or open graded materials meeting the requirements specified herein.
3. The drainage pipe (minimum 4-inch diameter) shall be placed immediately behind the wall at the bottom of the wall with a minimum of 1.5 percent gradient to maintain a positive gravity flow as shown or directed on Drawings.

G. Retained Backfill Placement:

1. As shown on Drawings, the retained backfill material shall be placed in maximum lifts of 10 inches and shall be compacted to a minimum 95 percent modified proctor dry density in accordance with ASTM D1557.

2. Only hand-operated compaction equipment shall be used within 5 feet of the back face of the gravity block wall units. This area shall be compacted to a minimum 90 percent of modified proctor dry density in accordance with ASTM D1557.

3. In-place soil density testing shall not be performed within 5 feet of the tail of the gravity block wall segmental concrete facing units.

4. The toe of the wall shall be filled and compacted as the wall is being constructed.

5. The fill areas shall be graded or protected to drain surface water run-off away from the wall face.

H. Tolerance: Wall batter tolerance of plus or minus 1/8 inch per foot maximum shall be allowed.

END OF SECTION
SECTION 32 91 13
SOIL PREPARATION

PART 1       GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):

1.02 SUBMITTALS

A. Action Submittals:

1. Samples: Representative of stockpiled or imported topsoil.

B. Informational Submittals:

1. Certified Topsoil Analysis Reports:
   a. Indicate quantities of materials necessary to bring onsite topsoil into compliance with textural/gradation requirements.
   b. Indicate quantity of lime, quantity and analysis of fertilizer, and quantity and type of soil additive.

1.03 SEQUENCING AND SCHEDULING

A. Rough grade areas to be planted or seeded. Perform Work specified in Section 31 10 00, Site Clearing, prior to performing Work specified under this section.

PART 2       PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and
deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition:
   1. In general accordance with ASTM D5268:
      a. Gravel-Sized Fraction: Maximum 5 percent by weight retained on a No. 10 sieve.
      b. Sand-Sized Fraction: Minimum 20 percent to 60 percent passing No. 10 sieve.
      c. Silt and Clay-Sized Fraction: Minimum 35 percent to 70 percent.

C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with ASTM D2974.

D. pH: Range 5.0 to 7.0.

E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

F. Source: Stockpile material onsite, in accordance with Section 31 10 00, Site Clearing. Import topsoil if onsite material is insufficient in quantity.

2.02 LIME

A. Composition: Ground limestone with not less than 85 percent total carbonates, ASTM C602.

B. Gradation:
   1. Minimum 50 percent passing No. 100 sieve.
   2. Minimum 90 percent passing No. 20 sieve.
   3. Coarser material acceptable provided rates of application are increased proportionately on basis of quantities passing No. 100 sieve.

2.03 SOIL ADDITIVES

A. Sawdust or Ground Bark:
   1. Nontoxic, of uniform texture, and subject to slow decomposition when mixed with soil.
   2. Nitrogen-treated, or if untreated mix with minimum 0.15 pound of ammonium nitrate or 0.25 pound of ammonium sulfate per cubic foot of loose material.
B. Peat:

1. Composition: Natural residue formed by decomposition of reeds, sedges, or mosses in a freshwater environment, free from lumps, roots, and stones.
   a. Organic Matter: Not less than 90 percent on a dry weight basis as determined by ASTM D2974.
   b. Moisture Content: Maximum 65 percent by weight at time of delivery.

C. Fertilizer:

1. Natural:
   a. Manure:
      1) Well-rotted, stable or cattle manure, free from weed seed and refuse.
      2) Maximum 50 percent sawdust or shavings by volume.
      3) Age: Minimum 4 months; maximum 2 years.

2. Commercial:
   a. Commercial, uniform in composition, free-flowing, suitable for application with equipment designed for that purpose.
   b. Contain the following minimum percentage of plant food by weight:
      1) Nitrogen: Amount as recommended in soils report from a qualified testing agency.
      2) Phosphoric Acid: Amount as recommended in soils report from a qualified testing agency.
      3) Potash: Amount as recommended in soils report from a qualified testing agency.

D. Sand:

1. Fine Aggregate: Clean, coarse, well-graded, ASTM C33/C33M.

2.04 SOURCE QUALITY CONTROL

A. Topsoil Analysis/Testing: Performed by county or state soil testing service or approved certified independent testing laboratory.
PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Apply lime at the rate of 50 pounds per 1,000 square feet to subgrade before tilling.

B. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

C. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

D. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Provide minimum 6-inch-thick topsoil course over all disturbed areas restored with seeding and planting.

B. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

C. Mix soil amendments, lime, and other soil additives, identified in analysis reports with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.

D. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth of 6 inches where seeding and planting are scheduled.

E. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

F. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

G. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION
PART 1 GENERAL

1.01 DEFINITIONS

A. Maintenance Period: Begin maintenance immediately after each area is planted (seed, sod, or sprig) and continue for a period of 8 weeks after all planting under this section is completed.

B. Satisfactory Stand:

1. Grass or section of grass that has:
   a. No bare spots larger than 3 square feet.
   b. Not more than 10 percent of total area with bare spots larger than 1 square foot.
   c. Not more than 15 percent of total area with bare spots larger than 6 square inches.

1.02 SUBMITTALS

A. Action Submittals: Product labels/data sheets.

B. Informational Submittals:

1. Seed:
   a. Certification of seed analysis, germination rate, and inoculation:
      1) Certify that each lot of seed has been tested by a testing laboratory certified in seed testing, within 6 months of date of delivery. Include with certification:
         a) Name and address of laboratory.
         b) Date of test.
         c) Lot number for each seed specified.
         d) Test Results: (i) name, (ii) percentages of purity and of germination, and (iii) weed content for each kind of seed furnished.
      2) Mixtures: Proportions of each kind of seed.

2. Seed Inoculant Certification: Bacteria prepared specifically for legume species to be inoculated.

3. Description of required maintenance activities and activity frequency.
1.03 DELIVERY, STORAGE, AND PROTECTION

A. Seed:
   1. Furnish in standard containers with seed name, lot number, net weight, percentages of purity, germination, and hard seed and maximum weed seed content, clearly marked for each container of seed.
   2. Keep dry during storage.

B. Hydroseeding Mulch: Mark package of wood fiber mulch to show air dry weight.

1.04 WEATHER RESTRICTIONS

A. Perform Work under favorable weather and soil moisture conditions as determined by accepted local practice.

1.05 SEQUENCING AND SCHEDULING

A. Complete Work specified in Section 32 93 00, Plants, and prepare topsoil as specified in Section 32 91 13, Soil Preparation, before starting Work of this section.

B. Complete Work under this section within 3 days following completion of soil preparation.

C. Notify Engineer at least 3 days in advance of:
   1. Each material delivery.
   2. Start of planting activity.

D. Planting Season: Those times of year that are normal for such Work as determined by accepted local practice.

1.06 MAINTENANCE SERVICE

A. Contractor:
   1. Perform maintenance operations during maintenance period to include:
      a. Watering: Keep surface moist.
      b. Washouts: Repair by filling with topsoil, liming, fertilizing, seeding, and mulching.
      c. Mulch: Replace wherever and whenever washed or blown away.
      d. Mowing: Mow to 2 inches after grass height reaches 3 inches, and mow to maintain grass height from exceeding 3-1/2 inches.
e. Reseed unsatisfactory areas or portions thereof immediately at the end of the maintenance period if a satisfactory stand has not been produced.

f. Reseed/replant during next planting season if scheduled end of maintenance period falls after September 15.

g. Reseed/replant entire area if satisfactory stand does not develop by July 1 of the following year.

PART 2 PRODUCTS

2.01 FERTILIZER

A. As specified in Section 32 91 13, Soil Preparation.

2.02 SEED

A. Fresh, clean new-crop seed that complies with the tolerance for purity and germination established by Official Seed Analysts of North America.

B. Seeds of Legumes: Inoculated with pure culture of nitrogen-fixing bacteria prepared specifically for legume species in accordance with inoculant manufacturer’s instructions.

<table>
<thead>
<tr>
<th>Wetland Seed Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Species</strong></td>
</tr>
<tr>
<td>Red Fescue</td>
</tr>
<tr>
<td>Tall Mannagrass</td>
</tr>
<tr>
<td>Meadow Barley</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Upland Seed Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Density</strong></td>
</tr>
<tr>
<td>Red Fescue</td>
</tr>
<tr>
<td>Oregon Bentgrass</td>
</tr>
<tr>
<td>Fowl Bluegrass</td>
</tr>
</tbody>
</table>

30 lbs/ac

C. Winter Protective Seed: Winter barley.
2.03 STRAW MULCH
   A. As specified in Section 01 57 13, Temporary Erosion and Sediment Control.

2.04 HYDROSEEDING MULCH
   A. As specified in Section 01 57 13, Temporary Erosion and Sediment Control.

2.05 TACKIFIER
   A. As specified in Section 01 57 13, Temporary Erosion and Sediment Control.

PART 3 EXECUTION

3.01 PREPARATION
   A. Grade areas to smooth, even surface with loose, uniformly fine texture.
      1. Roll and rake, remove ridges, fill depressions to meet finish grades.
      2. Limit such Work to areas to be planted within immediate future.
      3. Remove debris, and stones larger than 1-1/2-inch diameter, and other objects that may interfere with planting and maintenance operations.
   B. Moisten prepared areas before planting if soil is dry. Water thoroughly and allow surface to dry off before seeding. Do not create muddy soil.
   C. Restore prepared areas to specified condition if eroded or otherwise disturbed after preparation and before planting.

3.02 FERTILIZER
   A. Apply evenly over area in accordance with manufacturer’s instructions. Mix into top 2 inches of topsoil, when applied by broad cast method.
   B. Application Rate: Determined by soil test results in accordance with Section 32 91 13, Soil Preparation.

3.03 SEEDING
   A. Start within 2 days of preparation completion.
   B. Hydroseed slopes steeper than 4H:1V. Flatter slopes may be mechanically seeded.
   C. Only wetland seed mix shall be used in wetland areas. Do not seed wetland area with winter protective mix.
D. Mechanical: Broadcast seed in two different directions, compact seeded area with cultipacter or roller.

1. Sow seed at uniform rate of 5 pounds per 1,000 square feet.
2. Use Brillion type seeder.
3. Broadcasting will be allowed only in areas too small to use Brillion type seeder. Where seed is broadcast, increase seeding rate 20 percent.
4. Roll with ring roller to cover seed, and water with fine spray.

E. Hydroseeding:

1. Application Rate: As specified in Section 01 57 13, Temporary Erosion and Sediment Control.
2. Apply on moist soil, only after free surface water has drained away.
3. Prevent drift and displacement of mixture into other areas.
4. Upon application, allow absorption and percolation of moisture into ground.
5. Mixtures: Seed and fertilizer may be mixed together, apply within 30 minutes of mixing to prevent fertilizer from burning seed.

F. Cover Crop Seeding: Apply seed at rate of 120 pounds per acre to areas that are bare or incomplete after September 15.

G. Mulching:

1. Apply uniform cover of straw mulch as specified in Section 01 57 13, Temporary Erosion and Sediment Control.
2. Apply hydroseeding mulch as specified in Section 01 57 13, Temporary Erosion and Sediment Control.

H. Erosion Control Matting: Place over mulched and seeded areas as specified in Section 01 57 13, Temporary Erosion and Sediment Control.

I. Tackifier: Apply in mulched areas with slopes steeper than 4:1 as specified in Section 01 57 13, Temporary Erosion and Sediment Control.

J. Water: Apply with fine spray after mulching to saturate top 4 inches of soil.

3.04 FIELD QUALITY CONTROL

A. 8 weeks after seeding is complete and on written notice from Contractor, Engineer will, within 15 days of receipt, determine if a satisfactory stand has been established.
B. If a satisfactory stand has not been established, Engineer will make another
determination after written notice from Contractor following the next growing
season.

END OF SECTION
SECTION 32 93 00  
PLANTS

PART 1  GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. Federal Housing Administration (FHA), Section 1103-103.

1.02 DEFINITIONS

A. Measurement:

1. In size grading Balled and Burlapped (B & B), caliper takes precedence over height.
2. Take trunk caliper 6 inches above the ground level (up to and including 4-inch caliper size) and 12 inches above the ground level for larger trees.
3. Measure size of container-grown stock by height and width of plant.
4. Measure herbaceous perennials pot size, not top growth.

1.03 SUBMITTALS

A. Action Submittals:

1. Plant materials source list.
2. Product data on manufactured products specified.
3. Cuttings Harvest Plan:
   a. The Contractor shall submit to and obtain approval from the Engineer the site proposed for harvesting live cuttings for this item, prior to collecting any cuttings from the Project Site. Information to be provided in the Submittal includes:
      1) A figure showing the location(s) of the proposed harvest site(s).
      2) A list of species to be harvested from the proposed site(s).
      3) The number of cuttings (per species) to be collected from the proposed site(s).
      4) The length and diameter range of live cuttings to be harvested.
      5) The proposed dates of harvest.
6) The methods and equipment proposed to collect the cuttings.
7) The methods and equipment proposed to transport and store the cuttings until the time of installation.

b. The Engineer will require up to 15 working days for review of the proposed Cuttings Harvest Plan submittal. In addition to reviewing the Contractor’s submittal, the review process may include visiting the proposed harvest site(s) and surveying plant populations, and evaluating whether the proposed site(s) can support the quantity of proposed harvest.

c. At all approved harvest sites, the Contractor shall comply with all local, state, and Federal Regulations.

4. For live cuttings to be supplied from a nursery, the Contractor shall provide the name, location, and contact information for each nursery supplier.

B. Informational Submittals:

1. Soil percolation test results.
2. Operation and Maintenance Data:
   a. As specified in Section 01 78 23, Operation and Maintenance Data.
   b. Instructions for storage, planting, care, and maintenance of each type of plant for 1-year period in climate and location of the Project.
3. Special guarantee.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Cover plants during shipment with a tarpaulin or other suitable covering to minimize drying.

B. Balled and Burlapped Plants: Wrap each ball firmly with burlap and securely bind with twine, cord, or wire for shipment and handling. Drum-lace balls with a diameter of 30 inches or more.

C. As specified herein for transplanting.

1.05 SPECIAL GUARANTEE

A. Provide extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for removal and replacement with new plants those transplanted or newly planted plants found defective or to be dead or not in a vigorous, thriving condition during a period of 1 year after the date of Substantial Completion. Duties and obligations for
correction or removal and replacement of defective Work as specified in the General Conditions.

B. Replace defective plants with new plants free of dead or dying branches and branch tips, and bearing foliage of a normal density, size, and color. Closely match new plants to adjacent specimens of the same species and meet requirements of this Specification.

C. Plant replacement plants that die during a season unfavorable for planting during first month of next favorable planting season.

D. Plants damaged or lost due to Project (or any part thereof) occupancy, vandalism, or acts of neglect by others are not subject to this special guarantee.

1.06 MAINTENANCE

A. Commence to maintain plant life immediately after planting and maintain for a minimum of one growing season, and until plants are well established and exhibit a vigorous growing condition through special guarantee period.

B. In accordance with accepted Submittal on care and maintenance of plants and as follows:

1. Maintain by watering, pruning, cultivating, and weeding as required for healthy growth. Restore planting saucers.
2. Tighten and repair stake and guy supports and reset trees and shrubs to proper grades or vertical position as required.
3. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease.
4. Remove guys, stakes, and other supports at end of maintenance service.
5. Maintenance includes temporary protection fences, barriers, and signs as required for protection.
6. Coordinate watering to provide deep root watering to newly installed trees.

1.07 SCHEDULING AND SEQUENCING

A. Plant Deliveries: Notify Engineer at least 2 days in advance of each delivery.

B. Planting Season: Conduct planting during times of year that are normal for such work as determined by accepted local practice.

C. Plant trees and shrubs after final grades are established and before planting of lawns or grasses.
PART 2  PRODUCTS

2.01  PLANT MATERIALS

A. Provide quantity, size, genus, species, and variety of trees and shrubs indicated; comply with applicable requirements of AAN Z60.1.

B. Nomenclature (Names of Plants): In accordance with “Hortus Third”.

C. Quality and Size:
   1. Nursery-grown, habit of growth normal for species.
   2. Sound, healthy, vigorous, and free from insects, diseases, and injuries.
   3. Equal to or exceeding measurements specified in plant list. Measure plants before pruning with branches in normal position.
   4. Root System of Container-Grown Plants: Well developed and well distributed throughout the container, such that the roots visibly extend to the inside face of the growing container.
   5. Perform necessary pruning at time of planting.
   6. Sizes: Dimensional relationship requirements of AAN Z60.1 for kind and type of plants required.
   7. Balled and Burlapped Plants: Firm, intact ball of earth encompassing enough of the fibrous and feeding root system to enable full plant recovery.
      a. Ball Size: AAN Z60.1.
      a. Stock: Grown in delivery containers for at least 6 months but not over 2 years.
   9. Label each tree and shrub of each variety with securely attached waterproof tag bearing legible designation of botanical and common name.

D. Plant List: Attached to end of this section.

E. Replacement Shrubs and Trees: Same species, size, and quality as specified for plant being replaced, except existing trees larger than 4-inch caliper may be replaced with 4-inch caliper trees.
2.02 LIVE STAKES

A. Live stakes shall be from live cuttings collected from an approved site (based on approval of the cuttings Harvest Plan submittal, Article Submittals). The Contractor will be responsible for the collection, handling, delivery, storage, placing, and disposal of all materials used on this Project. All cuttings used for live stakes shall be sound, healthy, vigorous, and free from plant disease, infection, or decay.

B. For onsite harvest sources, no more than 10 cuttings or no more than 20 percent of a single plant, whichever is greater, shall be taken from any one parent plant. For offsite harvest sources, the Contractor shall collect live cuttings in accordance with local, state, and federal law.

C. Length and diameter of live stakes shall be determined by specific use as outlined in these specifications and as shown on Drawings.

D. Trim all leaves and secondary branches from live stakes prior to storage or installation.

E. Potential species suitable for live stakes are provided in the Plant List at the end of this section. Preferred species and the recommended ratio for each application are indicated on Drawings.

2.03 ANTIDESICCANT

A. Provide transpiration retarding material to be used where any plant material is moved during the growing season.

B. Products:
   1. Foliguard.
   2. Wiltpruf.

2.04 GUYING, STAKING, AND WRAPPING MATERIALS

A. Wood Stake: 2 inches by 2 inches by 8 feet.

B. Tree Ties: 1-inch size chainlock tree ties as manufactured by Green Brothers, Ltd.

C. Guy Wires: Galvanized, 12-gauge, ductile steel.
D. Flags:
   1. Wood: 1/2 inch by 3 inches by 12 inches, with 3/8-inch hole centered 1-1/2 inches from each end, painted white.
   2. Sheet Metal: 1-1/2 inch with clipped corners and both ends punched, painted white.

E. Hose: Two-ply, reinforced rubber garden hose, not less than 1/2-inch diameter, new or used.

F. Turnbuckles: Zinc-coated, with 6-1/2-inch lengthwise opening, and at each end 3/8-inch diameter threaded openings fitted with screw eyes.

G. Wrapping Material: Heavy crepe paper.
   1. Burlap: Of first quality, minimum 8 ounces in weight, not less than 6 inches nor more than 10 inches in width.

H. Deadmen: 6 inches by 6 inches by 3 feet long pressure treated timbers.

2.05 MULCH

A. Free from noxious weed seed and foreign material harmful to plant growth.

B. Barkdust: Medium grind, fir, pine, or hemlock; maximum 3/4-inch particle size.

2.06 HERBICIDE

A. Selective, pre-emergent, surface-applied.

B. Manufacturers and Products:
   1. Eli Lilly and Co.; Surflan.
   2. Thompson-Hayward Chemical Co.; Casoron.

2.07 PLANTING SOIL MIX

A. Top Soil: Amend to meet requirements of soil analysis as specified in Section 32 91 13, Soil Preparation.
2.08 FERTILIZER

A. Commercial, complete, of neutral character; in granular, packet, or pellet form, 35 percent to 80 percent of nitrogen slow release.
   1. Minimum: 10 percent available nitrogen, 3 percent to 5 percent phosphoric acid, and 3 percent to 5 percent soluble potash.

B. Organic, Slow Release, Mix by Volume:
   1. Fishmeal or Seedmeal: 4 parts.
   2. Agricultural Lime or Dolomite: 1 part; passing No. 65 screen or finer.
   3. Rock Phosphate: 1 part, or bonemeal: 1/2 part.

2.09 SOURCE QUALITY CONTROL

A. Top Soil Analysis/Testing: As specified in Section 32 91 13, Soil Preparation.

PART 3 EXECUTION

3.01 PERCOLATION TESTS

A. Perform to determine subsoil drainage in planting areas by licensed engineer according to method specified in Minimum Property Standards For One- and Two-Unit Dwellings, FHA Section 1103-103.

B. Test Hole Depth: 30 inches.

3.02 LOCATION OF PLANTS

A. Locate new planting or stake positions as shown, unless obstructions are encountered, in which case notify Engineer.

B. Locate no planting, except ground cover, closer than 18 inches to pavements, pedestrian pathways, and structures.

C. Request Engineer observe locations and adjust as necessary before planting begins.

3.03 PREPARATION

A. Subsoil Drainage: Furnish for plant pits and beds after percolation test results are received.
B. Planting Soil: Delay mixing of amendments and fertilizer if planting will not follow preparation of planting soil within 2 days. For pit and trench type backfill, mix planting soil prior to backfilling and stockpile at Site.

C. Plants: Place on undisturbed existing soil or well-compacted backfill.

D. Trees and Shrubs:
   2. B & B Trees and Shrubs: Make excavations at least twice as wide as root ball.
   4. Bare-Root Trees: Excavate pits to a width to just accommodate roots fully extended and depth to allow uppermost roots to be below original grade.
   5. Fill excavations with water and allow to percolate out prior to planting.

E. Ground Cover Beds:
   1. Mix amendments and fertilizer with top soil prior to placing or apply on surface of top soil and mix thoroughly before planting.
   2. Scarify top soil to a depth of 4 inches to 6 inches.
   3. Establish finish grading of soil. Rake areas to smooth and create uniform texture and fill depressions.
   4. Moisten.

3.04 PLANTING

A. Plant trees before planting surrounding smaller shrubs and ground covers. Adjust plants with most desirable side facing toward the prominent view (sidewalk, building, street).

B. B & B Plants: Place in pit by lifting and carrying by its ball (do not lift by branches or trunk). Lower into pit. Set straight and in pit center with tip of rootball 1 inch to 2 inches above adjacent finish grade.

C. Bare-Root Plants: Spread roots and set stock on cushion of planting soil mixture. Set straight in the pit center so that roots, when fully extended, will not touch walls of the planting pit and the uppermost root is just below finish grade. Cover roots of bare-root plants to the crown.

D. Container-Grown Plants: Remove containers, slash edges of rootballs from top to bottom at least 1-inch deep. Plant as for B & B plants.
E. Ground Covers: Dig planting holes through mulch with one of the following: hand trowel, shovel, bulb planter, or hoe. Split biodegradable pots or remove nonbiodegradable pots. Root systems of all potted plants shall be split or crumbled. Plant so roots are surrounded by soil below the mulch. Set potted plants so pot top is even with existing grade.

3.05 BACKFILLING

A. Backfill with planting soil, except where existing soil is suitable according to top soil analysis.

B. B & B Plants:

1. Partially backfill pit to support plant. Remove burlap and binding from sides and tops of B & B plants, do not pull burlap from under balls.
2. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill to eliminate air pockets even if it is raining. Finish backfilling pit sides.
3. Never cover top of rootball with soil. Form a saucer above existing grade, completely around the outer rim of the plant pit.

C. Bare-Root Plants:

1. Plumb before backfilling and maintain plumb while working backfill around roots and placing layers above roots.
2. Set original soil line of plant 1 inch to 2 inches above adjacent finish landscape grades. Spread out roots without tangling or turning up to surface. Cut injured roots cleanly; do not break.
3. Carefully work backfill around roots by hand; puddle with water until backfill layers are completely saturated.

3.06 GUYING, STAKING, AND WRAPPING

A. Support trees immediately after planting to maintain plumb position.

B. Guying: Support deciduous trees over 4 inches in caliper and all coniferous trees with three guys equally.

C. Staking: Support deciduous trees 4 inches in caliper or less with stakes spaced equally about each tree.

D. Wrapping: Spirally wrap trunks of deciduous trees from ground line to height of second branches, promptly after planting. Wrap neatly and snug. Hold material in place with raffia cord at top and bottom.
3.07 FERTILIZER

A. Add as top dressing depending on plant size and manufacturer’s recommendation.

B. Organic:
   1. Trees and Shrubs: Spread within planting saucer, 1/2 cup per caliper inch on trees and 1 cup per 5-gallon volume of container on shrubs.
   2. Ground Cover: According to manufacturer’s recommendations.

3.08 MULCHING

A. Cover planting beds and area of saucer around each plant with 2-inch thick layer of mulch within 2 days after planting. Saturate planting area with water.

3.09 PRUNING AND REPAIR

A. Prune only after planting and in accordance with standard horticultural practice to preserve natural character of the plant. Perform in presence of Engineer. Remove all dead wood, suckers, and broken or badly bruised branches. Use only clean, sharp tools. Do not cut lead shoot.

3.10 WEED CONTROL

A. Maintain a weed-free condition within planting areas. Apply pre-emergent selective herbicide to mulched beds at manufacturer’s recommended rate of application.

3.11 PROTECTION OF INSTALLED WORK

A. Protect planting areas and plants against damage for duration of maintenance period.

3.12 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification:

   1. Plant Listing.

END OF SECTION
### PLANT LISTING

#### TREES

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Size</th>
<th>Genus</th>
<th>Species</th>
<th>Common Name Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>See Note 1</td>
<td>Live stake as specified</td>
<td>Salix</td>
<td>Hookeriana</td>
<td>Coast Willow</td>
</tr>
<tr>
<td>7</td>
<td>2-gallon pot</td>
<td>Alnus</td>
<td>Rubra</td>
<td>Red Alder</td>
</tr>
<tr>
<td>2</td>
<td>2-gallon pot</td>
<td>Thuja</td>
<td>Plicata</td>
<td>Red Cedar</td>
</tr>
</tbody>
</table>

**Note:**
1. Provide and install Coast Willow live stakes between FESL layers as specified in Section 31 32 20, Biotechnical/Streambank Stabilization.

#### SHRUBS

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Size</th>
<th>Genus</th>
<th>Species</th>
<th>Common Name Variety</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>1-gallon pot</td>
<td>Mahonia</td>
<td>Aquitolium</td>
<td>Oregon Grape</td>
</tr>
<tr>
<td>6</td>
<td>1-gallon pot</td>
<td>Ganltheria</td>
<td>Shallon</td>
<td>Salal</td>
</tr>
<tr>
<td>11</td>
<td>1-gallon pot</td>
<td>Polystichum</td>
<td>Manitum</td>
<td>Sword Fern</td>
</tr>
<tr>
<td>12</td>
<td>1-gallon pot</td>
<td>Rubus</td>
<td>Spectabilis</td>
<td>Salmon Berry</td>
</tr>
<tr>
<td>1</td>
<td>1-gallon pot</td>
<td>Vaccinium</td>
<td>Ovatum</td>
<td>Evergreen Huckleberry</td>
</tr>
<tr>
<td>As shown</td>
<td>1-gallon pot</td>
<td>Sambucus</td>
<td>Racemosa</td>
<td>Red Elderberry</td>
</tr>
</tbody>
</table>
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.
2. American Water Works Association (AWWA):
   c. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm).
   d. C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   e. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   g. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   h. C221, Fabricated Steel Mechanical Slip-Type Expansion Joints.
   i. C606, Grooved and Shouldered Joints.
3. ASTM International (ASTM):
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
1.02 SUBMITTALS

A. Action Submittals:
   1. Detailed pipe fabrication drawings showing pipe details, special fittings and bends, dimensions, coatings, and other pertinent information.
   2. Layout drawing showing location of each pipe section and each special length.
   3. Pipe pressure class.
   4. Wall thickness, reinforcing, and strength calculations.
   5. Product Data: Manufacturer’s data for couplings, saddles, gaskets, and other pipe accessories. Indicate maximum rated working pressure and test pressure for each item.

B. Informational Submittals: Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer’s recommendations and as specified in individual Specification(s) following this section.

B. Marking at Plant: Mark each pipe and fitting at plant. Include date of manufacture, manufacturer’s identification, specification standard, diameter of pipe dimension ratio, and other information required for type of pipe.

C. Pipe, specials, and fittings received at Project Site in damaged condition will not be accepted.

D. Gasket Storage: Store rubber gaskets in cool, well ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

E. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

F. Handling:
   1. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.
   2. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.
3. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.

4. Pipe and fittings shall not be stored on rocks or gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPE

A. As specified in the individual specification(s) following this section.

2.03 JOINTS

A. As specified in the individual specification(s) following this section.

2.04 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.

2. Couplings shall be rated for appropriate operating pressure and hydrostatic test pressure.

3. Exposed, bolted, sleeve-type couplings shall be lined and coated with fusion bonded epoxy in accordance with AWWA C213.

4. Buried, bolted, sleeve-type couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.
2.05 SERVICE SADDLES

A. Double strap design rated for 150 psi minimum working pressure.

2.06 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Modular Mechanical Seal:

1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
2. Assemble interconnected rubber links with Type 316 stainless steel bolts, nuts, and pressure plates.
3. Size modular mechanical seals according to manufacturer’s instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.
4. Manufacturers and Products:
   a. Thunderline/LinkSeal, Div. of PSI, Houston, TX; Link Seal.
   b. Calpico, Inc., South San Francisco, California; Sealing Linx.
   c. Advance Products and Systems, Lafayette, Louisiana; Innerlynx.

B. Wall Sleeves:

1. Diameter, ends, and length shall be as shown on Drawings.
2. Shall include integral seep ring to minimize seepage between metal sleeve and concrete.

C. Wall Couplings:

1. Diameter, ends, and length shall be as shown on Drawings.
2. Wall couplings shall provide flexible mechanical joint.
3. Body and end rings shall be coated with fusion bonded epoxy.
4. Body shall include integral seep ring.
5. Shall comply with AWWA C219.

2.07 FLANGES, FLANGE GASKETS, AND BOLTING MATERIALS

A. As specified in individual specifications following this section.

B. Flanges, bolting materials, and flange gaskets for steel flanges shall conform to AWWA C207.

C. Flanges, bolting materials, and flange gaskets for ductile iron flanges shall conform to AWWA C110 and AWWA C115.

D. Stainless steel bolting material shall conform to ASTM F593, Type 304 stainless steel, Group 1, Condition SH1, 2, 3 or 4.
E. If the flanges are coated, provide two washers for each bolt on each side of the flange to minimize damage to the coating as the nuts are tightened. Provide bolts of the proper length to accommodate the washers.

2.08 CONCRETE FOR THRUST BLOCKS

A. Thrust Block Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Reinforcing Steel: ASTM A615/A615M, Grade 60 deformed bars.

C. Welded Wire Fabric: ASTM A497/A497M.

D. Formwork: Plywood; earth cuts may be used as approved by Engineer.

2.09 PIPE LOCATING TAPE

A. As specified in Section 31 23 23.15, Trench Backfill.

2.10 PIPE BEDDING AND PIPE ZONE MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.11 TRENCH STABILIZATION MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

PART 3 EXECUTION

3.01 GENERAL

A. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

B. Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished.

C. Distributing Materials: Place materials along trench only as will be used each day, unless otherwise approved by Engineer. Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area.

3.02 EXAMINATION

A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.
B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer’s instructions.

3.03 PREPARATION OF TRENCH

A. Prepare trench as specified in Section 31 23 16, Excavation.

B. Unless otherwise permitted by Engineer, maximum length of open trench shall not exceed 200 feet.

3.04 INSTALLATION

A. General:

1. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.

2. Install individual pipe lengths in accordance with approved lay diagram. Misplaced pipe shall be removed and replaced.

3. Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.

4. Flanged Joints:
   a. Install perpendicular to pipe centerline.
   b. Bolt Holes: Straddle vertical centerline, aligned with connecting equipment flanges or as shown on Drawings.
   c. Use torque-limiting wrenches to provide uniform bearing and proper bolt tightness.
   d. Flange Type: Use flat-faced flange when joining with flat-faced ductile or cast iron flange.

5. Couplings:
   a. Install in accordance with manufacturer’s written instructions.
   b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
   c. Clean gaskets before installation.
   d. If necessary, lubricate with gasket lubricant for installation on pipe ends.
   e. Tighten coupling bolts progressively, drawing up bolts on opposite sides gradually until bolts have uniform tightness.

B. Buried Pressure Pipe:

1. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown on Drawings.
2. Placement:
   a. Keep trench dry until pipe laying and joining is completed.
   b. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
   c. Measure for grade at pipe invert, not at top of pipe.
   d. Excavate trench bottom and sides of ample dimensions to permit proper joining, welding, visual inspection, and testing of entire joint.
   e. Prevent foreign material from entering pipe during placement.
   f. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day’s work.
   g. In general, lay pipe upgrade with bell ends pointing in direction of laying.
   h. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
      1) Shorter pipe lengths.
      2) Special mitered joints.
      3) Standard or special fabricated bends.
   i. Check gasket position with feeler gauge to assure proper seating.
   j. After joint has been made, check pipe alignment and grade.
   k. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
   l. Prevent uplift and floating of pipe prior to backfilling.

3. Tolerances:
   a. Deflection From Horizontal Line: Maximum 2 inches.
   b. Deflection From Vertical Line: Maximum 1 inch.
   c. Joint Deflection: Maximum of 75 percent of manufacturer’s recommendation.
   d. Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.

4. Cover Over Top of Pipe: Minimum 3 feet, unless otherwise shown.


3.05 THRUST RESTRAINT

A. Location: At pipeline tees, plugs, caps, bends, and locations where unbalanced forces exist.

B. Thrust Blocking:
   1. Place only where shown on Drawings.
2. Quantity of Concrete: Sufficient to cover bearing area of pipe and provide required soil bearing area as shown on Drawings.
3. Place blocking so pipe and fitting joints are accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.06 CORROSION PROTECTION
A. Buried Pipe: As specified in the individual specifications following this section.
B. Notify Engineer at least 3 days prior to start of surface preparation, coating application, and corrosion protection work.

3.07 PLACEMENT OF PIPE LOCATING TAPE
A. Place pipe locating tape in accordance with Section 31 23 23.15, Trench Backfill.

3.08 PIPE BEDDING AND ZONE MATERIAL
A. Place pipe bedding and pipe zone material in accordance with Section 31 23 23.15, Trench Backfill.

3.09 FIELD QUALITY CONTROL
A. Pressure Leakage Testing: As specified in the individual specification(s) following this section.

3.10 CLEANING AND DISINFECTION
A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. Dispose of water and flushed foreign matter.
B. Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.
C. Disinfection: As specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   c. C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
   d. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches Through 12 Inches (100 mm Through 300 mm), for Water Transmission and Distribution.
   e. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   f. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm Through 300 mm), for Water, Wastewater, and Reclaimed Water Service.

2. ASTM International (ASTM):

3. NSF International (NSF).
1.02 SUBMITTALS

A. Action Submittals: Drawings showing pipe diameter, pipe class, dimension ratio (DR) and fitting details.

B. Product Data: Manufacturer’s data for couplings, saddles, gaskets, and other pipe accessories. Indicate maximum rated working pressure and test pressure for each item.

C. Informational Submittals:
   1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
   2. Hydrostatic Testing Plan:
      a. Submit at least 15 days prior to testing and at minimum, include the following:
         1) Testing dates.
         2) Piping systems and section(s) to be tested.
         3) Method of isolation.
         4) Method of conveying water from source to system being tested.
         5) Method of disposing of test water.
         6) Calculation of maximum allowable leakage for piping section(s) to be tested.
   3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
   4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe:
   1. PVC, conforming to requirements of AWWA C900.
   2. DR 18.
   3. Pipe to be used for potable water conveyance shall meet the requirements of NSF 61.
B. Joints:
   1. Rubber gasketed.
   2. Conform to AWWA C900.

C. Fittings: Ductile iron, conforming to AWWA C153 or AWWA C110.

D. Service Saddles:
   1. Double strap type with minimum strap width of 2 inches.
   2. Straps: Type 304 stainless steel.
   3. Saddles: Ductile iron, epoxy-coated, 10 mils minimum thickness.

E. Restrained Joints:
   1. Provide pipe restraint by system designed specifically for use with PVC pipe using mechanical joint anchor gland followers with wedges. Do not use systems with set screws, gripper rings, or gripper gaskets.
   3. Restrain push-on gasketed joints with a restraint harness designed specifically for PVC pipe.
      a. EBAA IRON Series 1900 Restraint Harness.

F. Corrosion Protection: As specified in Section 09 90 00, Painting and Coating, and Section 26 42 02, Galvanic Anode Cathodic Protection System.

**PART 3 EXECUTION**

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer’s instructions.

3.02 PREPARATION OF TRENCH

A. Prepare trench as specified in Section 31 23 16, Excavation.
3.03 INSTALLATION

A. In accordance with AWWA C605, ASTM D2321, and AWWA Manual 23.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:
   1. Rubber Gasketed: In accordance with manufacturer’s written instructions.
   2. Solvent Cemented: In accordance with ASTM D2855.

D. Pipe Bending for Horizontal or Vertical Curves:
   1. Bending of pipe barrels larger than 12 inches in diameter is not allowed.
   2. Radius of curves shall not exceed 75 percent of manufacturer’s recommended values.
   3. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection at Mechanical Joint: 75 percent of manufacturer’s recommended values.

3.04 INSPECTION AND HYDROSTATIC TESTING

A. General:
   1. Notify Engineer in writing at least 5 days in advance of testing. Perform testing in presence of Engineer.
   2. Using water as test medium, all newly installed pipelines must successfully pass hydrostatic leakage test prior to acceptance.
   3. Conduct field hydrostatic test on buried piping after trench has been completely backfilled and compacted. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
   4. Contractor may, if field conditions permit and as approved by Engineer, partially backfill trench and leave joints open for inspection and conduct an initial informal service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.
   5. Supply of Temporary Water: In accordance with Section 01 50 00, Temporary Facilities and Controls.
6. Dispose of water used in testing in accordance with federal, state, and local requirements.
7. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
8. Wait a minimum of 5 days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
9. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
10. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.
   b. Provide appropriate thrust blocking.

B. Hydrostatic Testing Procedure:

1. Furnish testing equipment, as approved by Engineer, which provides observable and accurate measurements of leakage under specified conditions.
2. Maximum Filling Velocity: 0.25 foot per second calculated based on full area of pipe.
3. Expel air from piping system during filling.
4. Test Pressure: As specified in the Pipe Schedule as shown on Drawings.
5. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
6. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding make-up water only as necessary to restore test pressure to within 5 psi of specified hydrostatic test pressure.
7. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

C. Maximum Allowable Leakage:

\[
L = \frac{ND(P)^{1/2}}{7400}
\]

where:

L = Allowable leakage, in gallons per hour.
N = Number of joints in tested line.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during leakage test, in pounds per square inch.

END OF SECTION
SECTION 33 05 01.10
HIGH-DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Article XXI-XXIV.
   c. B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
2. American Water Works Association (AWWA):
   a. C906, Polyethylene (PE) Pressure Piping and Fittings, 4 in. through 65 in. for Waterworks.
3. ASTM International (ASTM):
   a. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   b. A194/A194M, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   g. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
PHASE IV BEAVER CREEK WATER SUPPLY

k. F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure.
l. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

6. Plastics Pipe Institute (PPI):
   a. Handbook of PE Pipe.
   b. Technical Note 38, Bolt Torque for Polyethylene Flanged Joints.
   c. TR-33, Generic Butt Fusion Joining Procedure for Field Joining of Polyethylene Pipe.

1.02 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Catalog information confirming pipe, fittings, and other materials conform to requirements of this section.
      b. Drawings of specific connection details.
   2. Joint Logs of First Three Joints: Logs to be approved by the Design Engineer prior to installation of pipe.

B. Informational Submittals:
   1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
   2. Infrared temperature gun product data.
   3. Certificates of qualification for persons to be fusing HDPE pipe.
   4. Information on manufacturer and model of machine to be used for fusion of HDPE pipe.
   5. Testing Plan:
      a. Submit at least 15 days prior to testing and include the following as a minimum:
         1) Testing dates.
         2) Piping systems and section(s) to be tested.
         3) Method of isolation from existing piping and equipment.
         4) Method of isolation from instrumentation and other items not to be tested.
5) Method of conveying water from source to system being tested.
6. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
7. Test report documentation.
8. Installation Plan following the Plastic Pipe Institute, ASTM F2620, and manufacturer’s recommendations. Plan shall include, but not be limited to the following major components:
   a. Pipe and fitting storage.
   b. Pipe and fitting handling equipment.
   c. Proposed means to maintain required temperatures for fusing.
   d. Proposed means to shield fusing area from wind, snow, blowing dust, and rain.
   e. Proposed means to maintain uniform pipe wall temperature prior to fusing.
   f. Temperature Control Plan: Plan shall include means to reduce temperature of pipe to limit stated in Part 3 of this specification.
9. Fusion parameters including recommended limits of criteria recorded by data logger.
10. Fusion report for each joint, including information listed under Article Field Quality Control. Submit joint reports within 24 hours after fusion.
11. Gasket manufacturer’s table for recommended bolt torque and tightening pattern.

1.03 QUALITY ASSURANCE

A. Qualifications:
   2. Experienced in fabricating pipe of similar diameters and wall thickness required for the Work.
   3. Persons fusing HDPE pipe shall have a minimum of 1 year of experience and shall have received a minimum of 20 hours of training for fusing HDPE pipe from pipe supplier or fusing equipment supplier.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Shipping: Do not cut, kink, or otherwise damage pipe during transportation.

B. Storage and Handling:
   1. Pipe interiors are to be inspected and all debris removed prior to storage.
   2. Limit stacking of pipe to a height that will not cause excessive deformation of bottom layers of pipes under anticipated temperature conditions.
3. Do not exceed the stacking heights stated in AWWA Manual M55.
4. Where necessary, because of ground conditions, store pipe on wooden sleepers, spaced suitably and of such widths as not to allow deformation of pipe at point of contact with sleeper or between supports.
5. Comply with the requirements of the approved Installation Plan.
6. Keep pipe shaded from direct sunlight prior to fusion and installation in trench.

1.05 CONNECTIONS TO EXISTING PIPE

A. Fusing to Existing Pipe: Comply with manufacturer’s or distributor’s recommendations based on Site conditions and PPI TR-33.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pipe and Fittings:

1. Conform to requirements of AWWA C906.
2. In compliance with NSF 61.
3. Resin:
   a. Potable Water Transmission and Distribution Systems: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for PE 4710 material with cell classification of 445474C, or better. PE 4710 HDPE pipe and fittings shall be manufactured from bimodal resins. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F.
   b. Nonpotable Water Transmission and Distribution Systems: Polyethylene resin shall meet or exceed requirements of ASTM D3350 for:
      1) PE 4710 material manufactured from bimodal resin with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F.
5. Outside Diameter Basis: IPS.
6. Pipe lengths, fittings, and flanged connections to be joined by thermal butt-fusion shall be of a compatible resin mix for the fusion process.
7. Fittings:
   a. Polyethylene fittings shall have same or higher pressure rating as pipe.
   b. Sizes 12 Inches and Smaller: Molded and manufactured to requirements of ASTM D3261.
   c. Sizes Larger than 12 Inches: Thermal butt-fused fabricated.
d. Unless noted otherwise, provide fittings 14-inch and larger with a factory fused 4-foot-long spool on each end to facilitate onsite fusion.

B. Backup Rings:

1. Convoluted for Flanged Connections:
   a. ASTM A240/A240M, Type 316 stainless steel.
   b. Complete with one-piece, molded polyethylene flange adapters.
   c. Flanged Connections: Same or greater pressure rating as pipe.

2. Gaskets: Material, size, and thickness shall be as recommended by gasket manufacturer and in accordance with PPI Technical Note 38. Gasket manufacturer shall provide a table with recommended bolt torque and tightening pattern.

C. Joints: Thermal butt-fusion or electrofused, except where connecting to unions, valves, and equipment with flanged or threaded connections that may require future disassembly. Use appropriate transition fitting or adapter for all joints that are not thermal butt-fused or electro-fused.

D. Bolts, Nuts, and Washers:

2. Bolt Fabrication: In accordance with ASME B18.2.1
4. Nut Fabrication: In accordance with ASME B18.2.2.
5. Washers: Type 304 stainless steel. Same material as bolts in accordance with ASME B18.21.1.
6. Thread Lubricant: Provide bolt manufacturer’s recommended lubricant on bolt threads, nuts, nut face, and around bolt hole.
7. Corrosion Resistance: When used in submerged brine water applications, bolts, nuts, and washers shall be coated in polytetrafluoroethylene (PTFE) applied by fastener manufacturer.

E. Wall Anchor:

1. Material: Same as HDPE pipe.
2. Internal Diameter: Equal to adjacent pipe.
3. Shear Strength: Equal to or greater than tensile strength of adjacent pipe.
4. Fabrication: Butt fusion. Extrusion bead welding is not allowed.
PHASE IV BEAVER CREEK WATER SUPPLY

F. Electrofusion Flex Restraint:
   1. Material: HDPE.
   3. Designed for restraining movement of HDPE pipe.
   4. Manufacturers:
      a. Central Plastics Company.
      b. Industrial Pipe Fittings, IPF-Plasson.

G. Electrofusion Couplings:
   1. Material: HDPE.
   3. Designed for coupling HDPE pipe.
   4. Manufacturers:
      a. Central Plastics Company.
      b. ISCO Industries.

H. Concrete Thrust Blocks: See Section 33 05 01, Conveyance Piping—General.

I. Products that restrain HDPE pipe with wedges or clamps are not acceptable.

J. Corrosion Protection: As specified in Section 09 90 00, Painting and Coating, and Section 26 42 02, Galvanic Anode Cathodic Protection System.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Install polyethylene pipe in conformance with AWWA M55, PPI TR-33, ASTM F2620, and pipe manufacturer’s recommendations.
   2. Follow all requirements of approved Installation Plan where HDPE is to be installed in ambient temperatures less than 50 degrees F, in hot conditions or in windy conditions.
   3. Protect and install pipe in accordance with the Temperature Control Plan when contraction of pipe length may cause damage to or pull out from structures.
B. Joining: Butt-fuse pipes and fittings in accordance with pipe manufacturer’s recommendations. Depending on Site conditions, perform butt-fusion joining in or outside of excavated trench.

1. If HDPE pipe surface temperature is above 80 degrees F as measured with infrared temperature gun, allow pipe to cool prior to making any connections to flanges, existing pipeline systems, or structures.

2. Connect HDPE pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems with flanged connections as follows:
   a. Polyethylene flange adapter, thermally butt-fused to end of pipe. Flange “stub ends” are not allowed.
   b. Convoluted backing flange, as specified.
   c. Bolt and nut of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer’s standard.
   d. Follow requirements of PPI Technical Note 38 including mandatory 4-hour bolt re-torquing.

3. Special Precautions at Flanges: Support polyethylene pipe connected to heavy fittings, manholes, and rigid structures in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

4. Minimum Long-Term Field Bending Radius: Restricted to twice the minimum cold bending radius as recommended by AWWA M55, Table 8-2.

C. Placement in Trench:

1. Control water in trench per Section 31 23 19.01, Dewatering, and Section 31 23 23.15, Trench Backfill.
2. Handle joined pipeline in such a manner that pipe is not damaged by dragging it over sharp and cutting objects.
3. Position slings for handling pipeline away from butt-fused joints.
4. Remove sections of damaged pipe and replace it with undamaged pipe. Damaged pipe is defined as pipe with kinks or gouges exceeding 10 percent of pipe wall thickness.
5. Exercise care when lowering pipe into trench to prevent damage or twisting of pipe.
6. Buried Pipe: Snake pipe from one side of trench to other to allow for thermal and settling movements, and as recommended by pipe manufacturer.
7. At flanges, valves, and connections, excavate out trench bottom sufficiently to ensure clearance between undisturbed trench bottom and flange, valve, or connection.
3.02 FIELD QUALITY CONTROL

A. Joint Butt Fusion:

1. Measure and log each joint fusion by an electronic monitoring device (data logger) affixed to fusion machine. Data to be logged shall include the following and shall be capable of being retrieved electronically:
   a. Pipe size, dimensions, and wall thickness.
   c. Operator identification.
   d. Job identification number.
   e. Weld number.
   f. Fusion, heating, and drag pressure settings.
   g. Heater plate temperature.
   h. Time stamp showing when weld was performed.
   i. Heating and curing time of weld.
   j. Curing temperature readings and time stamps of readings.
   k. Error messages and warnings for out of range temperature or pressure settings.

2. In addition to logged items above, the following shall be logged or annotated on report:
   a. Location of joint being fused by pipeline station or by reference to pipe Shop Drawing.
   b. Ambient temperature, wind speed, precipitation, and humidity.
   c. Environmental actions taken (such as, use of tarps, enclosures, and blankets).
   d. Type of HDPE and manufacturer.

B. Joint Weld Inspection:

1. Visually examine each joint in accordance with the guidelines in ASTM F2620. Remove and replace any joints not meeting the standard.

2. Mechanical Joint Testing:
   a. Pipe Wall Thickness 1-Inch or Less: Test joints in accordance with bend back testing provided in Appendix X4 of ASTM F2620.
   b. Pipe Wall Thickness Greater than 1-Inch: Test joints in accordance with the guided side bend testing in accordance with ASME BPVC, Section IX, Article XXI-XXIV.
   c. Specimens: Cut pipe 12 inches on each side of field made joint. Rejoin ends and proceed with Work.
   d. Test Frequency:
      1) First 1,000 Linear Feet: Two joints selected at random by Engineer.
      2) Each Additional 2,000 Linear Feet: One joint selected at random by Engineer.
3) Each Test Failure: Two additional joints selected at random by Engineer.

C. Pipeline Hydrostatic Test:

1. General:
   a. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
   b. Furnish testing equipment and perform tests in manner satisfactory to Engineer. Testing equipment shall provide observable and accurate measurements of initial service leak and allowable make-up water volume under specified conditions.
   c. Test newly installed pipelines.
   d. Isolate new pipelines that are connected to existing pipelines.
   e. Using water as test medium, pipes shall successfully pass a hydrostatic test prior to acceptance.
   f. Conduct field hydrostatic test on buried piping after trench has been completely backfilled. Testing may, as approved by Engineer, be done prior to placement of asphaltic concrete or roadway structural section.
   g. Contractor may, if field conditions permit and as determined by Engineer, partially backfill trench and leave joints open for inspection and conduct initial service leak test. Final field hydrostatic test shall not be conducted until backfilling has been completed as specified above.
   h. Supply of temporary water shall be as stated in Section 01 50 00, Temporary Facilities and Controls.
   i. Dispose of water used in testing in accordance with federal, state, and local requirements.

2. Preparation:
   a. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
   b. Wait 5 days minimum after concrete thrust blocking or designed thrust collars are installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
   c. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
   d. New Piping Connected to Existing Piping: Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Engineer.

3. Procedure:
   a. Test pressure shall be as specified in the Pipe Schedule as shown on Drawings.
b. Maximum filling velocity shall not exceed 0.25 feet per second, calculated based on full area of the pipe.

c. Expel air from pipe system during filling.

d. Test procedure shall be in accordance with ASTM F2164.
   1) Initial Expansion Phase: Add water as required to maintain test pressure for 4 hours.
   2) Test Phase: Reduce pressure by 10 psi and start pressure test.
   3) Test is successful if pressure stays within 5 percent of initial value for 1 hour.

e. If test is not completed because of leakage, equipment failure, or other reasons, depressurize test section and allow it to relax for at least 8 hours before retesting.

f. If there is leakage, repair defective pipe section and repeat hydrostatic test.

3.03 DISINFECTION

A. Conform to the requirements of Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

B. Active chlorine concentration shall not exceed 10 percent.

3.04 MANUFACTURER’S SERVICES

A. Provide pipe manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, for assistance during pipe joining operations and pipe installation.
PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:


2. ASTM International (ASTM):
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).

1.02 AMERICAN IRON AND STEEL REQUIREMENT

A. All iron and steel products must be produced in the United States per the American Iron and Steel (AIS) requirements mandated by Section 746 of Title VII of the Consolidated Appropriations Act of 2017 and subsequent statutes mandating domestic preference. Refer to USDA Rural Utilities Service (RUS) Bulletin 1780-35 for requirements, applicability, and exceptions.

1.03 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings, including details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.
   2. Product Data:
      a. Concrete mix design.
      b. Rubber gaskets and sealants.

B. Informational Submittals:
   1. Experience Record:
      a. Precast concrete production capabilities.
      b. Evidence of current PCI plant certification.
   3. Manufacturer’s recommended installation instructions.
   4. Field quality control report.
1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years’ experience producing precast concrete products of quality specified.

2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials of Construction and Service Conditions:

1. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.

2. Gaskets:
   a. Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
      1) Sanitary sewage.
      2) Corrosion or rotting under wet or dry conditions.
      3) Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
      4) Biological environment in soils and sanitary sewers.
      5) Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
      6) Temperature ranges, variations, and gradients in construction area.
      7) Variations in moisture conditions and humidity.
      8) Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.
      9) Vibrations because of traffic loading.
     10) Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.

3. Materials shall be compatible with each other and manhole materials.

4. Designed to provide a 20-year service life.
B. Structures shall meet requirements of ASTM C478, this specification and the following:

1. Concrete:
   a. Cement: Meet requirements of ASTM C150/C150M.
   b. Compressive Strength:
      1) Minimum 4,000 psi.
      2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.

2. Reinforcement: Grade 60, unless otherwise specified.

3. Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.

4. Joint:
   a. Form joint contact services with machined castings.
   b. Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.

5. Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Riser Sections:

1. Fabricate in accordance with ASTM C478.
3. Wall Thickness: Minimum 4 inches or 1/12 times inside diameter, whichever is greater.
4. Top and bottom surfaces shall be parallel.

B. Flat Top Sections:

1. Eccentric.
2. Top and bottom surfaces shall be parallel.

C. Base Sections and Base Slab:

1. Base slab integral with sidewalls.
2. Fabricate in accordance with ASTM C478.

D. Manhole Extensions:

1. Concrete grade rings; maximum 6 inches high.
2. Fabricate in accordance with ASTM C478.
E. Joint Seal Manufacturers and Products:

1. Butyl Gaskets:
   a. Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
   b. Henry Company, Houston, TX; Ram-Nek.
   c. Trelleborg Engineered Solutions, Park Hills, MO; NPC Bidco C-56.

2. Confined Plastic or Rubber O-Ring:
   a. As recommended by precasting manufacturer.
   b. Meet requirements of ASTM C443.

2.03 MANHOLE FRAMES AND COVER

A. Castings:

   1. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
   2. Cast Iron: ASTM A48/A48M Class 30B.
   4. Plane or grind bearing surfaces to ensure flat, true surfaces.

B. Cover: True and seat within ring at all points. With the word GAUGE in 2-inch raised letters.

2.04 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures:

   1. May be included; do not exceed the following percentages of weight of cement:
      a. Hydrated Lime: 10 percent.
      b. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

   1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
   2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.
2.05 BACKFILL AROUND AND UNDER MANHOLE
A. Granular fill as specified in Section 31 23 23, Fill and Backfill.

2.06 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE
A. Manufacturers and Products:
   1. NPC, Inc., Milford, New Hampshire; Kor-N-Seal flexible rubber boot with stainless steel accessories.
   2. A-LOK Products, Inc., Tullytown, PA; Z-LOK XP or A-LOK flexible connectors.

PART 3 EXECUTION

3.01 GENERAL
A. Prior to installation inspect materials:
   1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
   2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Owner and Engineer.
   3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL
A. Excavation: As specified in Section 31 23 16, Excavation.
B. Backfill: As specified in Section 31 23 23, Fill and Backfill.

3.03 INSTALLATION OF PRECAST MANHOLES
A. Concrete Base:
   1. Precast:
      a. Place on compacted structural fill.
      b. Properly locate, ensure firm bearing throughout, and plumb first section.
B. Sections:
   1. Inspect precast manhole sections to be joined.
   2. Clean ends of sections to be joined.
   3. Do not use sections with chips or cracks in tongue.

C. Preformed Plastic Gaskets or Rubber O-Ring:
   1. Use only pipe primer furnished by gasket manufacturer.
   2. Install gasket material in accordance with manufacturer’s instructions.

D. Extensions:
   1. Provide on manholes in streets or other locations where change in existing grade may be likely.
   2. Install to height not exceeding 12 inches.
   3. Lay grade rings in mortar with sides plumb and tops level.
   4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE FRAMES AND COVERS
   A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.
   B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

3.05 MANHOLE PIPING
   A. Flexible Joints:
      1. Provide in pipe not more than 1-1/2 feet from manhole walls.
      2. Where last joint of pipe is between 1-1/2 feet and 6 feet from manhole wall, provide flexible joint in manhole wall.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

2. ASTM International (ASTM):
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
3. Occupational Safety and Health Administration (OSHA):

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Detailed drawings showing complete information for fabrication including, but not limited to:
      1) Member dimensions and cross sections; location, size, and type of reinforcement, including additional reinforcement.
      2) Layout dimensions and identification of each precast unit.
      3) Welded connections indicated by AWS standard symbols.
      4) Details of connections, joints, accessories, and openings or inserts.
5) Watertight joint details.
6) Location and details of anchorage devices.
7) Access door details.
8) Details of ladder and pull-up extension.
9) If applying slope after precasting, submit proposed procedure prior to application.

b. Product Data:
1) Precast concrete items; show materials of construction by ASTM reference and grade.
2) Joint sealants.

B. Informational Submittals:

1. Manufacturer’s data for lifting devices for handling and erection.
2. Manufacturer’s certification that vault design and manufacture comply with referenced ASTMs (for example, ASTM C857 and ASTM C858).
3. Vault design calculations signed by a civil or structural engineer registered in the State of Oregon.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Store each unit in a manner that will prevent cracking, distortion, warping, straining and other physical damage, and in a manner to keep marking visible.

B. Lift and support each unit only at designated lifting points and supporting points as shown on Shop Drawings.

PART 2 PRODUCTS

2.01 VAULT MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Oldecastle Precast.
2. Jensen Precast.
3. Hanson Pipe and Precast.

2.02 PRECAST CONCRETE VAULTS

A. Design Requirements:

1. In the event of a conflict between or among standards, the more stringent standard shall govern.
2. Comply with ASTM C858, except as modified herein.
3. Reinforcing Steel:
   a. Deformed Bars: ASTM A615/A615M, Grade 60.
   b. Welded Wire Fabric: ASTM A497/A497M.
4. Nominal Dimensions: As shown on Drawings.
5. Construction: Rigid type and behave monolithically.
7. Design Loads: As determined by ASTM C857, and by using Site-
specific values indicated in the Structural General Notes on Drawings
   and below.
   b. Designed to avoid flotation with a factor of safety equal to 1.2 and
      groundwater level at finish grade surface.
   c. Consider unbalanced soil loads and design for global stability of
      vault including sliding resistance with a minimum factor of safety
      of 1.5.
8. Design shall accommodate additional stresses or loads that may be
   imposed during factory precasting, transporting, erection, and
   placement.
9. Blockouts for penetrations shall be as shown on Drawings.
10. Sealant:
    a. Nonswelling preformed joint sealants to provide a lasting,
       watertight bond.
    b. Manufacturer and Product: Henry Company; RAM-NEK.
11. Mortar: Comply with ASTM C387/C387M, Type S or use Type I grout
    as specified in Section 03 62 00, Grouting.

B. Mark each member or element to indicate location in the structure, top
   surface, and date of fabrication.

C. Vault Floor:

   1. Slope of vault floor shall be as shown on Drawings.
   2. Slope may be applied after precasting, using mortar fill as specified in
      Section 03 30 00, Cast-in-Place Concrete, or Type I grout as specified in
      Section 03 62 00, Grouting.

2.03 LINING AND COATING

A. Interior lining and exterior coating shall conform to Section 09 90 00,
   Painting and Coating.
2.04 ACCESSORIES

A. Ladder:
   1. Provide vault with galvanized steel ladder. Conform to requirements of Section 05 50 00, Metal Fabrications. Provide with pull-up extension.

B. Sidewalk Doors and Hatches: HS-20 load rated, spring-assisted, lockable, galvanized steel or aluminum access door, size as indicated on Drawings. Hatch to utilize drainage channel style frame with minimum 1-1/2-inch coupler for watertightness. Connect coupler with 1-1/2-inch PVC pipe and daylight pipe to drain outside of vault. Conform to requirements of Section 05 50 00, Metal Fabrications. Doors and hatches shall be provided with antislip coating.

C. Pipe Connections to Vault: As shown on Drawings.

PART 3 EXECUTION

3.01 GENERAL

A. Possible Settlement: If subgrade is encountered that may require removal to prevent structure settlement, notify Engineer. Engineer will determine depth of over excavation and means of stabilizing subgrade prior to structure installation.

B. Place 6-inch minimum thickness of imported crushed aggregate material on undisturbed earth or modified subgrade; thoroughly compact with a mechanical vibrating or power tamper. Meet requirements of Article Excavation and Backfill.

3.02 EXCAVATION AND BACKFILL

A. Remove and keep water clear from excavation during construction.

B. Excavation: As specified in Section 31 23 16, Excavation.

C. Backfill: As specified in Section 31 23 23, Fill and Backfill, and Section 31 23 23.15, Trench Backfill.
3.03 INSTALLATION

A. Concrete Base:
   1. Place on prepared subgrade.
   2. Properly locate, ensure firm bearing throughout, and plumb first section.

B. Sections:
   1. Carefully inspect precast sections to be joined.
   2. Thoroughly clean ends of sections to be joined.
   3. Do not use sections with chips or cracks.

C. Joints:
   1. Fill joints between precast sections per manufacturer’s recommendation.
   2. Joints shall be watertight to prevent entrance of groundwater.
   3. Joint Finish: Dry pack interior of joints to provide smooth finish.

D. Setting Precast Vault: Install vault to elevations shown on Drawings.

E. Watertight construction below grade with no open cracks or spalls. Cracking and defective areas of concrete shall be repaired per requirements of Section 03 30 00, Cast-in-Place Concrete, and Section 03 64 23, Epoxy Resin Injection Grouting.

3.04 PIPE CONNECTION TO VAULT

A. Install products in accordance with manufacturer’s instructions.

END OF SECTION
SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1  GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. C651, Disinfecting Water Mains.
   d. C652, Disinfection of Water Storage Facilities.
   e. C653, Disinfection of Water Treatment Plants.
2. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
3. Oregon Administrative Rules, Chapter 333.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate Oregon and AWWA standards and this Specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Method of disposal for highly chlorinated disinfecting water.

1.03 SEQUENCING

A. Commence disinfection after completion of following:

1. Completion and acceptance of internal painting of system(s).
2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 WATER FOR DISINFECTION AND TESTING

A. Owner will supply potable water. Contractor shall convey in disinfected pipelines or containers.

2.03 DISINFECTANT

A. The following disinfectant product(s) shall be used:

1. Liquid sodium hypochlorite (bleach), intended for use in drinking water.

PART 3 EXECUTION

3.01 GENERAL

A. Conform to Oregon Health Authority rules for Public Water Systems (OAR Chapter 333).

B. Contractor’s Equipment:

1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.

2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Finished water and backwash pumps.

2. Clearwell.
3. Potable side of membrane filter system, per membrane system supplier’s recommendations and guidance.
4. Finished Water (Potable) Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
5. Flush but do not disinfect raw water pumps and pipelines.
6. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

D. Prior to application of disinfectants, clean pumps, tanks, filters, and pipelines of loose and suspended material.

E. Allow water and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY
A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPING AND PIPELINES
A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
4. Flush pipe through flushing branches and remove branches after flushing is completed.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.
3.04  PUMPS

A.  Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.

B.  Application:

1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of 3-hour period, solution shall have a strength of at least 50 ppm free chlorine.

2. Operate valves and pump appurtenances during disinfection to ensure disinfecting solution is dispersed into all parts of pump and lines.

3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 ppm after the 3-hour retention period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.

4. After chlorination, flush water from pump until water through unit is chemically and bacteriologically equal to permanent source of supply.

3.05  CLEARWELL

A.  Cleaning:

1. Clean interior surfaces using water under pressure before sterilizing.

2. Isolate tank from system to prevent contaminating materials from entering distribution system.

3. Cleaning shall:
   a. Remove deposits of foreign nature.
   b. Remove biological growths.
   c. Clean slopes, walls, top, and bottom.
   d. Avoid damage to structure.
   e. Avoid pollution or oil deposits by workers and equipment.

4. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank.

B.  Disinfecting Procedure: In accordance with AWWA C652, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

3.06  MEMBRANE FILTER SYSTEM

A.  Prior to disinfection, remove foreign material from filter system. Clean using potable water and tools suitable for adequate scrubbing and cleaning. Pump or drain scrub water from structures.
B. Disinfection Procedure: In accordance with AWWA C653, unless herein modified.

3.07 DISPOSAL OF CHLORINATED WATER
A. Do not allow flow into a waterway without neutralizing disinfectant residual.
B. See appendix of AWWA C651, AWWA C652, and AWWA C653 for acceptable neutralization methods.

3.08 TESTING
A. Collection of Samples:
   1. Coordinate activities to allow Samples to be taken in accordance with this Specification.
   2. Provide valves at sampling points.
   3. Provide access to sampling points.

B. Chlorine Concentration Sampling and Analysis:
   1. Collect and analyze Samples in accordance with Oregon regulations.
   2. Sampling Frequency for Disinfecting Solution: Minimum of two samples for initial chlorine addition and minimum of two samples following required contact time.
   3. Dechlorinated Disinfecting Wastewater Residual Samples: Minimum of one sample before beginning discharge and one sample every 10 minutes while dechlorinated water is being discharged.
   4. Analysis to be performed by qualified individual, with experience in measuring chlorine residuals. Samples will be analyzed using DPD colorimetric test kit method for free chlorine as described in latest edition of Standard Methods for Examination of Water and Wastewater.

C. After facilities have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to bacterial limitations for public drinking water supplies.
   1. Collect Samples in accordance with applicable AWWA Standard.
   2. Analyze Samples for coliform concentrations in accordance with latest edition of Standard Methods for the Examination of Water and Wastewater.
   3. Obtain and analyze a minimum of two Samples on each of 2 consecutive days from each separable facility or item being disinfected by standard procedures outlined by state and local regulatory agencies.
D. Turbidity Sampling and Analysis:

1. After facilities have been cleaned, disinfected, and refilled with potable water, Owner will take water Samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies.

2. If turbidity is in excess of the limit, dispose of the water in accordance with this Specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

E. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. American Society of Mechanical Engineers (ASME):
   c. BPVC SEC VIII, Division 1, Rules for Construction of Pressure Vessels.
   d. BPVC SEC IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
6. American Society of Safety Engineers (ASSE): Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems and Components.
7. American Water Works Association (AWWA):
   a. C207, Steel Pipe Flanges for Waterworks Service—Sizes 4 Inch through 144 Inch (100 mm through 3,600 mm).
   b. C228, Stainless-Steel Pipe Flanges for Water Service—Sizes 2 In. through 72 In. (50 mm through 1,800 mm).
   c. D100, Welded Steel Tanks for Water Storage.
8. American Welding Society (AWS):
   a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
   d. QC 1, Standard for AWS Certification of Welding Inspectors.
9. ASTM International (ASTM):
   f. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   g. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure of High-Temperature Service, or Both.
   i. A307, Standard Specification for Carbon Steel Bolts and Studs 60,000 PSI Tensile Strength.
   k. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

11. National Association of Corrosion Engineers (NACE): RP0178, Fabrication Details, Surface Finish Requirements, and Proper Design Consideration for Tanks and Vessels to be Lined for Immersion Service.
13. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
1.02  DEFINITIONS

A.  BCL: Bottom capacity level is elevation above which the required capacity is provided.
B.  CJP: Complete Joint Penetration.
C.  CWI: Certified Welding Inspector.
D.  Freeboard: Vertical distance from bottom of roof purlin at wall and TCL.
E.  MT: Magnetic Particle Testing.
F.  NDT: Nondestructive Testing.
G.  PJP: Partial Joint Penetration.
H.  PQR: Procedure Qualification Record.
I.  PT: Liquid Penetrant Testing.
J.  RT: Radiographic Testing.
K.  TCL: Top capacity level is elevation of the lip of the overflow.
L.  UT: Ultrasonic Testing.
N.  WPQ: Welder Performance Qualification.

1.03  SYSTEM DESCRIPTION

A.  Steel Tank System:
   1.  Welded steel tank and accessories, and anchors, as specified herein.
   2.  Site Grading: As specified in Section 31 23 16, Excavation.
   3.  Concrete for foundation as specified in Section 03 30 00, Cast-in-Place Concrete.
   4.  Piping: As specified.
   5.  Coating system as specified in Section 09 97 13, Steel Tank Coatings.
1.04 AMERICAN IRON AND STEEL REQUIREMENT

A. All iron and steel products must be produced in the United States per the American Iron and Steel (AIS) requirements mandated by Section 746 of Title VII of the Consolidated Appropriations Act of 2017 and subsequent statutes mandating domestic preference. Refer to USDA Rural Utilities Service (RUS) Bulletin 1780-35 for requirements, applicability, and exceptions.

1.05 DESIGN REQUIREMENTS

A. Design, as specified herein, a welded steel potable water tank and associated accessories, anchors, and foundation.

B. Tank Dimensions:

1. As indicated on Drawings and summarized below:
   a. Overflow Elevation: 261.50 feet.
   b. Top of Shell Elevation: 265.50 feet.
      1) Increase shell elevation as required for freeboard to maintain clearance of roof structure above design seismic sloshing wave in accordance with AWWA D100 and ASCE 7.
   c. 30 – Clearwell Tank No. 1:
      1) Storage Capacity: 500,000 U.S. gallons.
   d. 35 – Clearwell Tank No. 2:
      1) Storage Capacity: 250,000 U.S. gallons.

C. Design Loads:

1. In accordance with Section 01 61 00, Common Product Requirements, and as indicated on the Structural General Notes on Drawings.
2. Horizontal Wind Velocity and Loads: For overall stability and anchorage of tanks, calculate wind pressures in accordance with ASCE 7, AWWA D100, and state specialty codes that govern.
3. Wind Girders and Intermediate Stiffeners: In accordance with AWWA D100, Section 3.5.
4. Design for static water level during overflow event considering water level at 1 foot above overflow elevation.
5. Seismic Design Loads and Factors:
   b. Risk Category IV.
   c. Seismic Design Category D.
   d. Seismic Importance Factor $I_E = 1.50$.
   e. Site Class C.
f. $S_S = 1.50g$, $S_1 = 0.72g$.
g. $S_{DS} = 1.00g$, $S_{D1} = 0.62g$.
h. The U Scaling Factor = 0.67.
i. Use General Design Procedure AWWA D100, Section 13.2.9.2.
j. $R_1 = 3.0$, $R_c = 1.5$.
k. Use AWWA D100 Chapter 3 for design steel stresses.

6. Hydrodynamic Hoop Stress of Each Shell Course:
   a. Compute using AWWA D100 Section 13.5.4.2.3.
   c. Allowable Stress: Not to exceed maximum tensile stress set forth in AWWA D100 multiplied by 1.33 factor.

7. Vertical Buckling Stress:
   a. Compute maximum longitudinal shell compression stresses using AWWA D100, Section 13.5.4.2.1.
   b. Calculate tank shell section modulus and determine compressive bending stress for each shell course using computed overturning moments. Add tank dead load shell stress to compressive bending stress for each shell course.
   c. Allowable Stress: Not to exceed maximum local buckling stress set forth in AWWA D100, Table 10 or Table 11 multiplied by 1.33 factor.

8. Effective Stress:
   a. Calculate effective stress by combining total hydrodynamic plus static hoop tension stress with vertical compression stress using Von Mises Theory for two-dimensional stress. Assume tension stress is algebraically positive and compression stress is negative.
   b. Allowable Stress: Not to exceed maximum tensile stress set forth in AWWA D100 multiplied by 1.33 factor.

11. Maximum Anchor Spacing: 10 feet.
12. Other Loads:
   a. Painters’ trolley ring, 400-pound concentrated load at any point.
   b. Foundation criteria: As shown on the Structural General Notes on Drawings.
   c. Anchor Bolts: Embedment in concrete foundation shall be designed to develop the steel strength of the anchor in tension in accordance with ASCE 7, Section 15.7.5. Include supplemental reinforcing as required in accordance with ACI 318.

D. Welds Joining Tank Shells: CJP butt-joint welds. PJP groove welds not permitted.
1.06 SUBMITTALS

A. Action Submittals:

1. Foundation and tank construction drawings and calculations of steel tank system and accessories. Calculations shall be signed and sealed by Contractor’s tank designer. All details shall satisfy the minimum requirements, sizes, factors herein specified or shown.

2. Details of anchor bolt assembly including size, material, and placement method.

3. Welding Data (Shop and Field):
   a. Show on a weld map, complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tail of welding symbol.
   b. Clearly distinguish between shop and field welds.
   c. Welding and NDE Symbols: In accordance with AWS A2.4.
   d. Welding Terms and Definitions: In accordance with AWS A3.0.
   e. Submit welding data together with Shop Drawings as a complete package.

B. Informational Submittals:

1. Manufacturer’s instructions for coating systems.

2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

3. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

4. Manufacturer’s Test Reports:
   a. Mill certifications for steel tank plates.
   b. Mill certifications for structural steel.

5. Credentials and Statements of Qualification of Contractor’s Personnel and Subcontractors:
   a. Tank designer.
   b. Tank manufacturer.
   c. Tank installer.
   d. Welder/welder operator.
   e. Weld testing agency.
   f. Welding inspector.
   g. NDT personnel.
   h. Nonshrink grout manufacturer’s representative.
   i. Painting Subcontractor.

6. Welding Documentation:
   a. Shop and field WPSs and supporting PQRs.
   b. NDT procedure specifications.
c. Shop and field CWI reports.
d. Shop and field NDT reports.

7. Field Test Results:
a. Vacuum test for flat bottom floor plate welds.
b. Hydrostatic test report.

1.07 QUALITY ASSURANCE

A. Qualifications:

1. Tank and Foundation Designer: Registered professional engineer licensed to perform specified Work in the state of the Project.
2. Tank Installer: Certified by Tank Manufacturer as qualified to perform specified Work.
3. Experience requirements for Tank Manufacturer, Tank Designer and Tank Installer shall include five or more steel tanks presently in potable water service, of similar size and character to specified Work, all in satisfactory operation for minimum of 5 years.
4. Welder/Welding Operator: Qualified by Tank Manufacturer or Contractor in accordance with referenced welding codes.
5. CWI: Certified in accordance with AWS QC 1, and having prior inspection experience with specified welding codes.
6. Nondestructive Testing Personnel: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
7. Nonshrink Grout Manufacturer’s Representative: Authorized and trained representative of grout manufacturer with minimum 3 years’ experience in successful installation on steel tank projects. See additional requirements of Section 03 62 00, Grouting.
8. Painting Subcontractor: Minimum of 5 years’ experience in lining and coating of welded steel tanks for water storage.

B. Welding Documentation:

1. WPSs: In accordance with ASME BPVC, SEC IX (Forms QW-482 and QW-483) for shop welding and AWS D1.1 (Annex N Forms) for field welding.
2. WPQs: Qualified by tank fabricator in accordance with ASME BPVC, SEC IX (Form QW-484) for shop welding and AWS D1.1 (Annex N Forms) for field welding.
3. CWI certificate(s).
4. NDT personnel certifications.
C. Regulatory Requirements:

1. Tank Accessories: In accordance with applicable safety and building codes, including Code of Federal Regulations, 29 CFR 1910.27, Fixed Ladders, and OSHA.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MATERIALS

A. Steel:

1. Shell and Floor: AWWA D100, Section 3.
2. Roof: API STD 650 or AWWA D100.
3. Steel Plate: 1/4-inch minimum thickness.
4. Roof Columns: Steel pipe or structural tubing.
5. Rolled Shapes: ASTM A36 or ASTM A992.

2.03 ACCESSORIES

A. Shell Manholes:

1. Design in accordance with API STD 650 or ASME BPVC SEC VIII, Division 1.
2. Flanged and bolted type, AWWA C207, Class D, ring type with red rubber, ring type gaskets as indicated in AWWA C207, Table 1.
4. Cover: Blind flange per AWWA C207, Class D. Hinge to tank shell.
5. Bolts and Nuts: In accordance with AWWA C207, galvanized.
6. Nozzles: Minimum 1/2-inch-thick per ASTM A106/A106M, Grade B pipe or fabricated from rolled plate per ASTM A516/A516M, Grade 70.
B. Pipe Connections:
   1. Inlet-outlet and drain connections as shown on Drawings.
   2. Standard weight ASTM A53/A53M, Grade B, Type E or Type S, ASTM A106/A106M, Grade B, or as shown on Drawings.
   3. Fabricate in accordance with ASME B31.3, Normal Fluid Service category.

C. Reinforcing Plates at Shell Openings: In accordance with API 650, Section 5.7.2.

D. Overflow:
   1. Pipe: Standard weight, ASTM A53/A53M, Grade B, Type E or S, or ASTM A106/A106M, Grade B, and as shown.
   2. Overflow Weir:
      a. Plate: 1/4-inch thick.
   3. Flanges: AWWA C207, Class D, ring type.
   4. Roof Hatch: Size as indicated on Drawings with hinges, handle, hold-open device, hasp, lock, and weathertight seal.
   5. Curb: Extend minimum 6 inches above roof plate.
   6. Hatch Cover: Lap curb minimum 2 inches when closed with weathertight seal.
   7. Grind sharp edges and corners smooth.

E. Railing:
   1. 1-1/2-inch diameter, Schedule 40 steel pipe.
   2. Roll roof handrails to radius concentric with reservoir rim.
   3. Cap and weld pipe ends to seal out moisture where platform handrail posts bear on platform grating.

F. Interior and Exterior Ladders:
   1. In accordance with ALI A14.3 and 29 CFR 1910.27.
   2. Furnish safety cage in accordance with OSHA requirements.
   3. Hot-dip galvanize after fabrication.

G. Safety Climb Device:
   1. Furnish complete safety climb fall prevention systems, Saf-T-Climb System, for all interior and exterior ladders.
   2. Test equipment in accordance with ALI A14.3. Test harnesses in accordance with ASSE Z359.1.
   3. Provide Type 316L stainless steel system for interior ladder and hot-dip galvanized system for exterior ladder.
4. Each complete system shall allow worker to operate freely in normal climbing position during ascent or descent.
7. Removable extension kit for inside ladder with tie-down rod, mandrel, and carrier rail.
8. Furnish additional accessories required to complete system for each specific ladder.
10. Manufacturer: North Safety Products; toll free (800) 268-6925.

H. Rest Platforms and Landings:
1. Steel Grating: Metal bar type, rectangular, open construction.
3. Band edges with bars similar to main bearing bars.

I. LADDER CLIMB PREVENTION SHIELD
1. Eight feet long with angled sides to within 2 inches of wall when closed.
2. Furnish dissimilar metals protective coatings at bolted connections.
3. Manufacturer and Product: North Safety Products, Specialty Products Division, Toronto, Ontario, Canada; Ladder Gate 770-000-001.

J. Roof Vent:
1. Designed to relieve pressure or vacuum in event screen frosts over or is otherwise clogged.
2. Designed and sized for flow rate at the following conditions:
   a. Inlet (pressure condition): 1,000 gallons per minute.
   b. Outlet (vacuum condition): 8,000 gallons per minute.
3. Easily dismantled for maintenance.
4. Manufacturer and Product: Farr Type 44, 2-inch washable pleated high efficiency air filter in vents, with insect screens.

K. Painters’ Trolley Ring at Tank Interior: Minimum 1/4-inch by 4-inch curved plate supported a minimum of 4 inches clear of the tank wall at 4-foot intervals by 1/4-inch thick plate welded to tank shell.

L. Ringwall Grout: In accordance with Section 03 62 00, Grouting.

M. Caulking Manufacturer and Product: Sika; Flex 1A sealant.
N. Anchor Bolts and Nuts:
   1. Bolts: ASTM F1554, Grade 55 with supplements 1, 3, and 4.

O. Threaded Couplings: Black, forged steel, Class 3000, ASME B16.11.

P. Steel Pipe and Fittings:
   1. As specified in Section 40 05 15, Piping Support Systems.
   2. 48-inch and Smaller: ASTM A53/A53M, Type E or Type S, Grade B or
      ASTM A106/A106M, Grade B, black.
         A234M, beveled ends for CJP butt-joint welding or attaching
         flanges.
      b. Standard Weight: As shown.
   3. Flanges: AWWA C207, Class D, ring type, unless otherwise shown.
   4. Gaskets: 1/16-inch or 1/8-inch thick, to match flanges per
      AWWA C207, Table 1.
   5. Flange Bolt-Ups:
      a. Nonburied: Steel bolts, ASTM A307, Grade B, and steel nuts,
         ASTM A194/A194M, Grade 2H, galvanized.
      b. Buried: Stainless steel bolts, ASTM A193/A193M, B8M
         Type 316.

2.04 CONCRETE

A. As specified in Section 03 30 00, Cast-in-Place Concrete.

2.05 CONTROLS

A. In accordance with general control requirements and component qualities
   specified in Section 40 99 90, Package Control Systems.

2.06 FABRICATION

A. General:
   1. AWWA D100, Section 9 and Section 10.
   2. Shell Plate: Shop bent to radius shown.

B. Welding:
   2. Roof Columns: Cap welded at both ends.
3. Overflow Pipe: Weld support straps to pipe prior to coating interior of pipe.
4. Ladder Guard: Weld hinges and hasp staple to ladder rails.

C. Finish:

1. Shop prime as specified in Section 09 97 13, Steel Tank Coatings, unless otherwise noted.
2. For items embedded in concrete, coat as specified in Section 09 97 13, Steel Tank Coatings.
3. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.
4. Prepare galvanized surfaces to be painted in the field approximately 48 hours to 72 hours before painting as specified in Section 09 97 13, Steel Tank Coatings.

2.07 SOURCE QUALITY CONTROL

A. CWI shall be present whenever shop welding is performed. CWI shall perform inspection at suitable intervals prior to assembly, during assembly, during welding, and after welding. CWI duties include:

1. Verifying conformance of specified job material and proper storage.
2. Monitoring conformance with approved WPS.
3. Monitoring conformance of WPQ.
4. Inspecting weld joint fit-up and in-process inspection.
5. Providing 100 percent visual inspection of welds.
6. Supervising nondestructive testing personnel and evaluating test results.
7. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.

PART 3 EXECUTION

3.01 SITE GRADING

A. As specified in Section 31 23 16, Excavation.

3.02 GROUT

A. Ringwall or Slab: Fill 6-inch wide by 1-inch minimum space between steel tank baseplate and ringwall or slab as specified in Section 03 62 00, Grouting.

3.03 CONCRETE

A. Placement: As specified in Section 03 30 00, Cast-in-Place Concrete.
3.04 TANK ERECTION

A. General:
   1. Do not field bend steel plate.
   2. Use anchor bolts to anchor tank to concrete foundation.

B. Welded Joints:
   2. Continuously weld columns to baseplates and to roof structural support system.
   3. Continuously seal weld roof, exterior, and interior joints above and below elevation of top of shell curb angle to preclude crevice corrosion and rust discoloration.
   4. Close ends of steel pipe roof columns with 1/4-inch steel plate and seal weld ends.
   5. Roof Vent: Continuously weld joints for watertight installation.

3.05 WELDING

A. General:
   1. Perform in accordance with AWWA D100, ASME BPVC, SEC IX, Part QW (shop welding), and AWS D1.1 (field welding), except as modified herein.
   2. Perform only in presence of CWI.

B. Roof:
   1. Double-curved Plates: Complete penetration butt-joint welded.
   2. Flat or Single-curved Plates: Double-fillet welded.

C. Shell:
   2. Openings: Groove or fillet welded. Provide post weld heat treatment of CJP butt joint welds in material thicker than 1-1/2 inches.
   3. Shell to Floor or Annular Ring:

D. Floor:
   1. Floor Plates: Butt-joint welded or lap-joint welded in accordance with AWWA D100.
   2. Openings: Groove or fillet welded.
E. Anchor Bolt Attachments:
   1. Groove or fillet welded.
   2. Provide post-weld heat treatment of all complete penetration groove
      welds in material 1-1/4 inches or thicker.
   3. Fillet welds 5/16-inch minimum single pass.

F. Accessories and Attachments:
   1. Joints: Seal welded, as minimum.
   2. Steel Piping: Complete penetration butt-joint welded.

3.06 WELD DEFECT REPAIR

A. Repair and retest rejectable weld defects until sound weld metal has been
   deposited in accordance with weld acceptance indicated herein.

3.07 SAFETY CLIMB DEVICE

A. Install mandrel in accordance with manufacturer’s instructions to enable the
   worker to be attached to device at all times during climb without having to
   remove hands from ladder to operate system effectively and able to easily
   pivot onto and off of rest platforms or landings while safely attached to
   device.

B. When installed to any height, fall prevention system shall be extremely rigid
   and combine to become an integral part of structure.

3.08 FIELD FINISHING

A. As specified in Section 09 97 13, Steel Tank Coatings.

3.09 FIELD QUALITY CONTROL

A. CWI shall be present whenever field welding is performed. CWI shall perform
   inspection at suitable intervals prior to assembly, during assembly, during
   welding, and after welding. CWI duties include:

   1. Verifying conformance of specified job material and proper storage.
   2. Monitoring conformance with approved WPS.
   3. Monitoring conformance of WPQ.
   4. Inspecting weld joint fitup and in-process inspection.
   5. Providing 100 percent visual inspection of welds.
   6. Supervising nondestructive testing personnel and evaluating test results.
   7. Maintaining records and preparing report confirming results of
      inspection and testing comply with the Work.
B. Weld NDT:

1. 100 percent VT by CWI of all welds for acceptance in accordance with AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections, unless more stringent NDT is required in this specification section.

2. Roof: MT or PT at 10 percent rate per AWS D1.1/D1.1M, Table 6.1 for statically loaded nontubular connections.

3. Shell: Spot RT examine per AWWA D100, Sections 11.5, 11.6, or Chapter 14 as appropriate.
   a. Openings:
      1) Groove Welds: 100 percent UT per ASME BPVC, SEC VIII, D1, Paragraph UW-53, and Appendix 12.
      2) Fillet Welds: 100 MT or PT per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.
   b. Connection to Floor: 100 percent MT or PT per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.

4. Floor Opening Welds: 100 percent examine using NDT methods specified for shell opening welds.

5. Anchor Bolt Attachment Welds:
   a. 100 percent NDT of all welds that support first three consecutive anchor bolts at tank base as follows:
      1) Fillet Welds: MT per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.
      2) Groove Welds: UT per ASME BPVC, SEC VIII, D1, UW-53, and Appendix 12.
   b. If rejection rate exceeds 5 percent, 100 percent examine next three anchor bolt supports using same testing procedures and acceptance criteria.
   c. If rejection rate is less than 5 percent, testing rate may be reduced to 20 percent of welded connections.
   d. Engineer will determine welds to be tested.

6. Accessories and Attachments: MT at 10 percent rate per AWS D1.1/D1.1M, Table 6.1 for Statically Loaded Nontubular Connections.

C. Field Tests: In accordance with AWWA D100, Section 11:

1. Vacuum test flat bottom floor plate welds.

2. Hydrostatic test tank after painting is complete.
3.10 DISINFECTION

A. As specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

END OF SECTION
SECTION 33 41 01
STORM DRAIN AND DRAINAGE PIPING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Association of State Highway and Transportation Officials (AASHTO):

2. American Water Works Association (AWWA):
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75 mm Through 1200 mm) for Water and Other Liquids.
   e. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.

3. ASTM International (ASTM):
   b. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
i. C497, Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile.


l. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.


s. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.


w. F794, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

x. F894, Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

1.02 SUBMITTALS

A. Informational Submittals:

1. Manufacturer’s Certification of Compliance.

2. Product cutsheets.
PART 2 PRODUCTS

2.01 PIPE AND FITTINGS

A. As specified in the Data Sheets following “End of Section.”

PART 3 EXECUTION

3.01 INSTALLATION OF PIPE, FITTINGS, AND APPURTENNANCES

A. General:

1. Pipe laying shall proceed upgrade with spigot ends pointing in direction of flow.
2. Excavate bell holes at each joint to permit correct assembly and inspection of entire joint.
3. Pipe invert may deviate from line or grade up to 1/2-inch for line and 1/4-inch for grade, provided that finished pipe line will present a uniform bore, and such variation does not result in a level or reverse sloping invert, or less than minimum slope shown.
4. Pipe bedding shall form continuous and uniform bearing and support for pipe barrel between joints. Pipe shall not rest directly on bell or pipe joint.
5. Prevent entry of foreign material into gasketed joints.
6. Plug or close off pipes that are stubbed off for manhole, concrete structure, or for connection by others, with temporary watertight plugs.

B. Concrete Closure Collars: Only use concrete closure collars where shown or authorized by Engineer.

C. Perforated Underdrain: Lay with open joints and with perforations down.

3.02 SUPPLEMENTS

A. Data Sheets.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>-.03</td>
<td>Polyvinyl Chloride (PVC)</td>
</tr>
<tr>
<td>-.05</td>
<td>Reinforced Concrete</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 33 41 01.03
POLYVINYL CHLORIDE (PVC)

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe: 15-inch diameter and under</td>
<td>ASTM D3034: Standard dimension ratio 26, except that the cell classification shall be 12454-B or 12454-C as defined in ASTM D1784.</td>
</tr>
<tr>
<td>Joints</td>
<td>ASTM D3212 rubber gasketed.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>ASTM F477. Lubricants: As approved by manufacturer.</td>
</tr>
<tr>
<td>Fittings</td>
<td>PVC, gasketed. Provide plug when service piping is not required.</td>
</tr>
<tr>
<td>Plugs</td>
<td>Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.</td>
</tr>
<tr>
<td>Source Quality Control Testing</td>
<td>In accordance with specified ASTM.</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 33 41 01.05
REINFORCED CONCRETE

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>ASTM C76, Wall B, Class III unless shown otherwise. Mark each joint with pipe class. Rotating packer or platform not allowed.</td>
</tr>
<tr>
<td>Cement</td>
<td>ASTM C150, Type II, or</td>
</tr>
<tr>
<td></td>
<td>ASTM C150, Type I, with fly ash; maximum 12 percent Tricalcium Aluminate, or</td>
</tr>
<tr>
<td></td>
<td>ASTM C595 Rev A, Type IP, with fly ash; Cement: ASTM C150.</td>
</tr>
<tr>
<td></td>
<td>Minimum 564 pounds per cubic yard without fly ash.</td>
</tr>
<tr>
<td></td>
<td>Minimum 479 pounds per cubic yard with fly ash.</td>
</tr>
<tr>
<td>Ratio: Water to</td>
<td>Not over 0.49.</td>
</tr>
<tr>
<td>Cementitious</td>
<td></td>
</tr>
<tr>
<td>Materials</td>
<td></td>
</tr>
<tr>
<td>Fly Ash</td>
<td>ASTM C618, Class C or Class F, Tables 1 and 2 modified as follows:</td>
</tr>
<tr>
<td></td>
<td>Loss on Ignition: Maximum 3 percent</td>
</tr>
<tr>
<td></td>
<td>Water Requirement: Maximum 100 percent of control</td>
</tr>
<tr>
<td></td>
<td>Ratio Percent CaO/Fe₂O₃: Maximum 1.5</td>
</tr>
<tr>
<td></td>
<td>or test cement fly ash mix in accordance with ASTM C1012.</td>
</tr>
<tr>
<td></td>
<td>Mix: Equal to or better than ASTM C150, Type II cement.</td>
</tr>
<tr>
<td></td>
<td>85 pounds per cubic yard minimum, 160 pounds per cubic yard maximum.</td>
</tr>
<tr>
<td></td>
<td>Test: ASTM C311 and ASTM C618.</td>
</tr>
<tr>
<td>Rubber Gaskets</td>
<td>ASTM C443.</td>
</tr>
<tr>
<td>Tee Fittings</td>
<td>Reinforced concrete, rubber gasketed. Provide plug when service piping is not required.</td>
</tr>
<tr>
<td>Plugs</td>
<td>Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.</td>
</tr>
<tr>
<td>Circumferential</td>
<td>Not closer than 1 inch to inside surface of pipe. Area of outer circular reinforcing cage not less than 75 percent of inner cage.</td>
</tr>
<tr>
<td>Reinforcement</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Elliptical Reinforcement</td>
<td>Not allowed.</td>
</tr>
<tr>
<td>Source Quality Control Testing</td>
<td>Load Bearing 0.01-inch Crack, Compressive Strength and Absorption: ASTM C76. Load Bearing Ultimate: ASTM C76. Permeability: ASTM C497. Voids: Longitudinally sawcut one pipe from each 100 lengths of pipe manufactured in half with saw that will not damage the concrete or reinforcing steel. Inspect for voids adjacent to circumferential bars. Voids will be considered continuous if a 1/16-inch diameter pin can be inserted 1/4 inch deep. If voids exist adjacent to more than 10 percent of the circumferential bars, two additional pipes shall be tested. If either of the two pipes fail, the entire 100 lengths will be rejected.</td>
</tr>
</tbody>
</table>

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. ASTM International (ASTM):
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
3. International Code Council (ICC):
   b. International Mechanical Code (IMC).
4. Manufacturers’ Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for all piping. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.
2. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints. If support systems are revised, calculations for each type of pipe support, attachment and anchor are required.

3. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Maintenance information on piping support system.
2. Anchorage and bracing calculations, as required by Section 01 88 15, Anchorage and Bracing.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed and Shop Drawings prepared and sealed by a Registered Professional Engineer in the State of Oregon, where the Work is to be installed.

1.05 DESIGN REQUIREMENTS

A. General:

1. Locate piping support systems throughout facilities, whether shown or not on Drawings.
2. Support systems have been designed for some piping shown. Supports are shown only where specific types and locations are required; additional pipe supports are required.
3. Meet requirements of MSS SP 58 and ASME B31.3-2016 or as modified by this section.

B. Pipe Support Systems:

1. Design pipe support systems for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural General Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural General Drawings.
4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
   a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.
b. Ductile-iron Pipe 10 Inches and Larger: Maximum span limited to 20 feet.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

PART 2 PRODUCTS

2.01 GENERAL

A. When specified items are not available, fabricate pipe supports of correct material and to general configuration indicated.

B. Special support and hanger details may be required for cases where standard catalog supports are not applicable.

C. Materials: In accordance with Material Selection and Area Classification Table.

2.02 HANGERS

A. Clevis:

1. MSS SP 58, Type 1:
   a. Anvil; Figure 260 for steel pipe and Figure 590 for ductile-iron pipe, sizes 1/2 inch through 30 inches.
   b. Insulated Steel Pipe: Anvil; Figure 260 with insulated saddle system (ISS), sizes 1/2 inch through 16 inches.
   c. B-Line; Figure B3100, sizes 1/2 inch through 30 inches.

B. Adjustable Swivel Split-Ring Pipe Clamp:

1. MSS SP 58, Type 6:
   a. Anvil; Figure 104, sizes 3/4 inch through 8 inches.
   b. B-Line; Figure B3171, sizes 3/4 inch through 8 inches.

C. Steel Yoke Pipe Rolls and Roller Supports:

1. MSS SP 58, Type 41 or Type 43:
   a. Anvil; Figure 181 for sizes 2-1/2 inches through 24 inches, and Figure 171 for sizes 1 inch through 30 inches.
b. B-Line; Figure B3110 for sizes 2 inches through 24 inches and Figure B3114 for 30 inches.

D. Pipe Rollers and Supports:

1. MSS SP 58, Type 44:
   a. Anvil; Figure 175, sizes 2 inches through 30 inches.
   b. B-Line; Figure B3120, sizes 2 inches through 24 inches.

2.03 WALL BRACKETS, SUPPORTS, AND GUIDES

A. Welded Steel Wall Bracket:

1. MSS SP 58, Type 33 (heavy-duty):
   a. Anvil; Figure 199, 3,000-pound rating.
   b. B-Line; Figure B3067, 3,000-pound rating.

B. Adjustable “J” Hanger:

1. MSS SP 58, Type 5:
   a. Anvil; Figure 67, sizes 1/2 inch through 8 inches.
   b. B-Line; Figure B3690, sizes 1/2 inch through 8 inches.

C. Offset Pipe Clamp: Anvil; Figure 103, sizes 3/4 inch through 8 inches.

D. Channel Type:

1. Unistrut.
2. Anvil; Power-Strut.
3. B-Line; Strut System.
4. Aickinstrut (FRP).

2.04 PIPE SADDLES

A. Provide 90-degree to 120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.

1. In accordance with Standard Detail 4005-515.
2. Sizes 20 inches though 60 inches, Piping Technology & Products, Inc.; Fig. 2000.

B. Saddle Supports, Pedestal Type:

1. Minimum standard weight pipe stanchion, saddle, and anchoring flange.
2. Nonadjustable Saddle:
   a. MSS SP 58, Type 37 with U-bolt:
      1) Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
      2) B-Line; Figure B3095, sizes 1 inch through 36 inches with B3088S base.

3. Adjustable Saddle:
   a. MSS SP 58, Type 38 without clamp:
      1) Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
      2) B-Line; Figure B3092, sizes 3/4 inch through 36 inches with Figure B3088S base.

2.05 CHANNEL TYPE SUPPORT SYSTEMS

A. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.

B. Members and Connections: Design for loads using one-half of manufacturer’s allowable loads.

C. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

D. Manufacturers and Products:
   1. B-Line; Strut System.
   2. Unistrut.
   3. Anvil; Power-Strut.
   4. Aickinstrut (FRP System).
   5. Enduro-Durostrut (FRP Systems).

2.06 FRP PIPE SUPPORTS SYSTEMS

A. General:
   1. FRP with UV additive, protective veil, and vinyl ester resins resistance to chemicals listed in Supplement at end of section.
   2. Fire Retardant: ASTM E84.
   3. Include hangers, rods, attachments, and fasteners.

B. Clevis Hangers:
   1. Factor of Safety: 3 to 1.
C. Design:
   1. Design pipe supports spacing, hanger rod sizing based upon manufacturer’s recommendations.
   2. Identify and highlight non-FRP fasteners or components in Shop Drawing.

D. Manufacturers:
   1. Aickinstrut.
   2. Enduro.
   3. Century Composite.

2.07 PIPE CLAMPS

A. Riser Clamp: MSS SP 58, Type 8.
   1. Anvil; Figure 261, sizes 3/4 inch through 24 inches.
   2. B-Line; Figure B3373, sizes 1/2 inch through 30 inches.

2.08 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches, Anvil; Figure 62C base.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches, Anvil; Figure 63A or Figure 63B base.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches, Standon; Model S89.

2.09 INTERMEDIATE PIPE GUIDES

A. Type: Hold down pipe guide.
   1. Manufacturer and Product: B-Line; Figure B3552, 1-1/2 inches through 30 inches.

B. Type: U-bolts with double nuts to provide nominal 1/8-inch to 1/4-inch clearance around pipe; MSS SP 58, Type 24.
   1. Anvil; Figure 137 and Figure 137S.
   2. B-Line; Figure B3188 and Figure B3188NS.
2.10 PIPE ALIGNMENT GUIDES
A. Type: Spider.
B. Manufacturers and Products:
   1. Anvil; Figure 255, sizes 1/2 inch through 24 inches.
   2. B-Line; Figure B3281 through Figure B3287, sizes 1/2 inch through 24 inches.

2.11 PIPE ANCHORS
A. Type: Anchor chair with U-bolt strap.
B. Manufacturer and Product: B-Line; Figure B3147A or Figure B3147B.

2.12 SEISMIC RESTRAINTS
A. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.
B. Manufacturers:
   1. Mason Industries.
   2. B-Line.
   3. Anvil.

2.13 ACCESSORIES
A. Anchor Bolts:
   1. Size and Material: As specified in Section 05 50 00, Metal Fabrications, or Section 05 05 19, Post-Installed Anchors.
   2. Bolt Length (Extension Above Top of Nut):
      a. Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
      b. Maximum Length: No more than a full nut depth above top of nut.
B. Dielectric Barriers:
   1. Plastic coated hangers, isolation cushion, or tape.
   2. Manufacturer and Products:
      a. B-Line; B1999 Vibra Cushion.
      b. B-Line; Iso Pipe, Isolation Tape.
C. Insulation Shields:
   1. Type: Galvanized steel or stainless steel, MSS SP 58, Type 40.
   2. Manufacturers and Products:
      a. Anvil; Figure 167, sizes 1/2 inch through 24 inches.
      b. B-Line; Figure B3151, sizes 1/2 inch through 24 inches.

D. Welding Insulation Saddles:
   1. Type: MSS SP 58, Type 39.
   2. Manufacturers and Products:
      a. Anvil; Figure Series 160, sizes 1 inch through 36 inches.
      b. B-Line; Figure Series B3160, sizes 1/2 inch through 24 inches.

E. Plastic Pipe Support Channel:
   1. Type: Continuous support for plastic pipe and to increase support spacing.
   2. Manufacturer and Product: B-Line; Figure Series B3106V, sizes 1/2 inch through 6 inches with Figure B3106 Vee bottom hanger.

F. Hanger Rods, Clevises, Nuts, Sockets, and Turnbuckles: In accordance with MSS SP 58.

G. Attachments:
   1. I-Beam Clamp: Concentric loading type, MSS SP 58, Type 21, Type 28, Type 29, or Type 30, which engage both sides of flange.
   2. Concrete Insert: MSS SP 58, Type 18, continuous channel insert with load rating not less than that of hanger rod it supports.
   3. Welded Beam Attachment:
      a. MSS SP 58, Type 22:
         1) Anvil; Figure 66.
         2) B-Line; Figure B3083.
   4. U-Channel Concrete Inserts: As specified in Section 05 50 00, Metal Fabrications.
   5. Concrete Attachment Plates:
      a. Anvil; Figure 47, Figure 49, or Figure 52.
      b. B-Line; Figure B3084, Figure B3085, or Figure B3086.
PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Support no pipe from pipe above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not use adhesive anchors for attachment of supports to ceiling or walls.
8. Do not install pipe supports and hangers in equipment access areas or bridge crane runs.
9. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
10. Install lateral supports for seismic loads at changes in direction.
11. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
12. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.
3. Horizontal Piping Supported from Floors:
   a. Saddle Supports:
      1) Pedestal Type, elbow and flange.
      2) Provide minimum 1-1/2-inch grout beneath baseplate.
b. Floor Mounted Channel Supports:
   1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
   2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
   3) Attach pipe to channel with clips or pipe clamps.

c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.

4. Insulated Pipe:
   a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
   b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
   c. Wall-mounted pipe clips not acceptable for insulated piping.

5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings:
   a. Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
      1) Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
      2) Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
         a) These lines include air operated diagram pumps.
   
2. Steel Beams: I-beam clamp or welded attachments.

3. Wooden Beams: Lag screws and angle clips to members not less than 2-1/2 inches thick.

4. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.

5. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to 120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.
E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Welding Insulation Saddle: Install on insulated steel pipe with oversize rollers and supports.
3. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

END OF SECTION
PART 1        GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

4. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.15, Cast Copper Alloy Threaded Fittings Classes 125 and 250.
   i. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   k. B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings Classes 150, 300, 600, 900, 1500, and 2500.
   l. B16.25, Buttwelding Ends.
   m. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   n. B31.1, Power Piping.
   p. B31.9, Building Services Piping.
   q. B36.10M, Welded and Seamless Wrought Steel Pipe.
6. American Water Works Association (AWWA):
   h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
   i. C606, Grooved and Shouldered Joints.

7. American Welding Society (AWS):
   b. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
   d. QC1, Standard for AWS Certification of Welding Inspectors.

8. ASTM International (ASTM):
l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
m. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
t. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
w. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
z. A409/A409M, Standard Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High-Temperature Service.
y. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
z. D2000, Standard Classification System for Rubber Products in Automotive Applications.


fff. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.


9. FM Global (FM).


13. NSF International (NSF):
   b. ANSI 372: Drinking Water System Components - Lead Content.
1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
   a. Top face of channel walls and cover slabs.
   b. Liquid surface or within 3 feet above top of liquid surface.
   c. Top of tank wall or under tank cover.

1.03 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

2. Buried Piping: H20-S16 traffic load with 1.5 impact factor, AASHTO HB-17, as applicable.

B. All other piping has been designed per ASME B31.3, Normal Fluid Service unless otherwise shown on Drawings or Specifications. Fabrication, examination, and testing of piping shall comply with Code.

1.04 AMERICAN IRON AND STEEL REQUIREMENT

A. All iron and steel products must be produced in the United States per the American Iron and Steel (AIS) requirements mandated by Section 746 of Title VII of the Consolidated Appropriations Act of 2017 and subsequent statutes mandating domestic preference. Refer to USDA Rural Utilities Service (RUS) Bulletin 1780-35 for requirements, applicability, and exceptions.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Fabricated Piping:
   a. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
   b. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
3. Thrust Blocks: Concrete quantity, bearing area on pipe, and fitting joint locations.
4. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
5. Pipe Corrosion Protection: Product data.
6. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s Certification of Compliance, in accordance with Section 01 61 00, Common Product Requirements:
   a. Pipe and fittings.
   b. Factory applied resins and coatings.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer’s product data sheets for gaskets including torquing requirements and bolt tightening procedures.
4. Qualifications:
   b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
   c. Welders:
      1) Continuity log for welders and welding operators.
      2) Welder qualification test records conducted by Contractor or manufacturer.
5. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Test logs.
8. Pipe coating applicator certification.
10. CWI inspection records and NDE test records.
11. Component and attachment testing certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years’ experience in field of welding and welded pipe and fittings’ testing required for this Project.
   b. Calibrated instruments and equipment, and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
e. Verification Welding Inspector: AWS QC1 Certified.

2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor’s CWI: Certified in accordance with AWS QC1, and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Engineer.
5. Solvent Welder For Double Wall Containment Piping: Qualified in accordance with Chapter VII of the ASME B31.3 Code, Part 9, Paragraph A328.

B. Quality Assurance: Provide services of independent inspection and testing agency for welding operations.

1. Note, the presence of Owner’s Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.07 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements, and:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.
PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. As specified on Piping Data Sheet(s), and on Piping Schedule located on Drawings.

B. Diameters Shown:

2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.

2.03 JOINTS

A. Grooved End System:

1. Rigid type.
2. Use of flexible grooved joints allowed where shown on Drawings or with prior approval by Engineer.
3. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.

B. Flanged Joints:

1. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
2. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.

C. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.
D. Mechanical Joint Anchor Gland Follower:

1. Ductile iron anchor type, wedge action, with break-off tightening bolts.
2. Thrust rated to 250 psi minimum.
3. Rated operating deflection not less than:
   a. 3 degrees for sizes through 12 inches.
   b. 2 degrees for sizes 14 inches through 16 inches.
   c. 1.5 degrees for sizes 18 inches through 24 inches.
   d. 1 degree for sizes 30 inches through 48 inches.
4. UL and FM approved.

E. Flexible Mechanical Compression Joint Coupling:

1. Stainless steel, ASTM A276, Type 305 bands.
2. Manufacturers:
   a. Pipeline Products Corp.
   b. Fernco Joint Sealer Co.

F. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:

1. Polyethylene stub end thermally butt-fused to end of pipe.
2. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.
3. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer’s standard. Retorque nuts after 4 hours.
4. Gaskets as specified on Data Sheet.

2.04 GASKET LUBRICANT

A. Lubricant shall be supplied by pipe manufacturer and no substitute or “or-equal” will be allowed.

2.05 DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. System components shall be pre-engineered, factory fabricated, tested, and assembled such that field assembly is minimized to primarily that of straight joints.

2.06 PIPE CORROSION PROTECTION

A. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.
B. Heat Shrink Wrap:

1. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
2. Manufacturer and Product: Raychem; WPC or TPS.

C. Polyethylene Encasement (Bagging):

1. Encasement Tube: Black polyethylene encasement tube, 8 mils minimum thickness, conforming to AWWA C105/A21.5, free of gels, streaks, pinholes, foreign matter, undispersed raw materials, and visible defects such as tears, blisters, and thinning at folds.
2. Securing Tape: Thermoplastic tape, 8 mils minimum thickness, 1 inch wide, pressure sensitive adhesive face capable of bonding to metal, bituminous coating, and polyethylene encasement tube.

D. Insulating Flanges, Couplings, and Unions:

1. Materials:
   a. In accordance with applicable piping material specified in Pipe Data Sheet. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
   b. Galvanically compatible with piping.
   c. Resistant for intended exposure, operating temperatures, and products in pipeline.
2. Union Type, 2 Inches and Smaller:
   a. Screwed or solder-joint.
   b. O-ring sealed with molded and bonded insulation to body.
3. Flange Type, 2-1/2 Inches and Larger:
   a. Flanged, complete with bolt insulators, dielectric gasket, bolts, and nuts.
   b. Bolt insulating sleeves shall be provided full length between insulating washers.
   c. Ensure fit-up of components of insulated flange assembly to provide a complete functioning installation.
   d. AWWA C207 steel flanges may be drilled oversize up to 1/8-inch to accommodate insulating sleeves.
   e. No less than minimum thread engagement in accordance with specified bolting standards will be permitted to accommodate thicknesses of required washers, flanges, and gasket.
4. Flange Insulating Kits:
   a. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
   b. Insulating Sleeves: Full-length mylar.
   c. Insulating Washers: High-strength phenolic.
d. Steel Washers: Hardened steel, ASTM F436, 1/8 inch thick.
   1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
   2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.

5. Manufacturers and Products:
   a. Dielectric Flanges and Unions:
      1) PSI, Houston, TX.
      2) Advance Products and Systems, Lafayette, LA.
   b. Insulating Couplings:
      1) Dresser; STAB-39.
      2) Baker Coupling Company, Inc.; Series 216.

2.07 THRUST BLOCKS

   A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.08 THRUST TIES

   A. Steel Pipe: Fabricated lugs and rods in accordance with details shown on Drawings.
   B. Buried Ductile Iron Pipe and Fittings: Unless restraint is otherwise specified or shown, conform to NFPA 24. Tie-rod attachments relying on clamp friction with pipe barrel to restrain thrust are unacceptable.

2.09 VENT AND DRAIN VALVES

   A. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
   B. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

2.10 FABRICATION

   A. Mark each pipe length on outside with the following:
      1. Size or diameter and class.
      2. Manufacturer’s identification and pipe serial number.
      3. Location number on laying drawing.
      4. Date of manufacture.
   B. Code markings according to approved Shop Drawings.
C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.11 FINISHES

A. Factory prepare, prime, and finish coat in accordance with Pipe Data Sheet(s) and Piping Schedule as shown on Drawings.

B. Galvanizing:
   1. Hot-dip applied, meeting requirements of ASTM A153/A153M.
   2. Electroplated zinc or cadmium plating is unacceptable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. See Piping Schedule as shown on Drawings and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Engineer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer’s instructions, except for damaged glass-lined pipe that is to be promptly removed from Site.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Keep paper record of which welder welded each joint.
C. Pipe End Preparation:
   2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.

D. Surfaces:
   1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
   2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
   3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:
   1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
   2. Root Opening of Joint: As stated in qualified welding procedure.
   3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions:
   1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
   2. Preheat per Code requirements and approved WPS.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.
B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.
3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
10. Manufacturer: Same as pipe manufacturer or grooved joint flange adapter manufacturer.

D. Threaded and Coupled Joints:

2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets.

E. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer’s latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer’s standards and to AWWA C606.
2. Install grooved joint couplings and gaskets in accordance with manufacturer’s latest published installation instructions.
F. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

G. Brazed Joints for Refrigerant Piping:

1. Braze copper piping with silver solder complying with AWS A5.8/A5.8M.
2. Construct joints according to AWS Brazing Handbook, Chapter Pipe and Tube.
3. Inside of tubing and fittings shall be free of flux.
4. Clean parts to be joined with emery cloth and keep hot until solder has penetrated the full depth of the fitting and extra flux has been expelled.
5. Cool joints in air and remove flame marks and traces of flux.
6. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel the air.
7. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

H. Pipe Connections at Concrete Structures: As specified in Article Piping Flexibility Provisions in Section 40 27 01, Process Piping Specialties.

I. PVC and CPVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

J. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.
K. High-Density Polyethylene Piping:

1. Join pipes, fittings, and flange connections by means of thermal butt-fusion.
2. Perform butt-fusion in accordance with pipe manufacturer’s recommendations as to equipment and technique.
3. Special Precautions at Flanges: Polyethylene pipe connected to heavy fittings, manholes, and rigid structures shall be supported in such a manner that no subsequent relative movement between polyethylene pipe at flanged joint and rigid structures is possible.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes:
   a. Provide flexible mechanical compression joints for pressure pipe.
   b. Provide concrete closure collar as shown.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day’s work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Install closure sections and adapters for gravity piping at locations where pipe laying changes direction.
10. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
   a. Shorter pipe lengths.
   b. Special mitered joints.
   c. Standard or special fabricated bends.
11. After joint has been made, check pipe alignment and grade.
12. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
13. Prevent uplift and floating of pipe prior to backfilling.

C. PVC, CPVC, or HDPE Pipe Placement:
   1. Lay pipe snaking from one side of trench to other.
   2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
   3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
   4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:
   1. Deflection from Horizontal Line: Maximum 2 inches.
   2. Deflection From Vertical Grade: Maximum 1/4 inch.
   3. Joint Deflection: Maximum of 75 percent of manufacturer’s recommendation.
   4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
   5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 INSTALLATION—DOUBLE WALL CONTAINMENT PIPING SYSTEM

A. Install according to manufacturer’s instructions.

B. Valves and equipment shall be supported independently from pipe. Anchor valves such that turning moment resulting from their operation will not be transmitted to pipe.
C. Centering Devices for Double Wall Containment Piping:
   1. Center and support carrier pipe within the containment pipe with centering devices. Locate per manufacturer recommendations, or within 24 inches of the termination of containment pipe on fabricated pieces.
   2. Install centering devices such that leak detection cable (if specified) will be unrestricted and such that system maintains free drainage.

D. Following Installation and Testing:
   1. Flush clean carrier and containment piping system.
   2. Purge annular space of moisture with clean, dry air.

3.09 LEAK DETECTION SYSTEM FOR DOUBLE WALL CONTAINMENT PIPING
A. Install in accordance with system manufacturer’s instructions and recommendations.

3.10 PIPE CORROSION PROTECTION
A. Ductile Iron Pipe: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule as shown on Drawings.
B. Carbon Steel Pipe: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule as shown on Drawings.
C. Copper Pipe: As specified in Section 09 90 00, Painting and Coating, and as shown in Piping Schedule as shown on Drawings.
D. PVC and CPVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.
E. Piping Accessories:
   1. Exposed:
      a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.
      b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.
   2. Buried:
      a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
      b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.
e. Cement-Coated Pipelines: Cement coat appurtenances same as pipe.

F. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer’s instructions.

G. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

H. Heat Shrink Wrap: Apply in accordance with manufacturer’s instructions to surfaces that are cleaned, prepared, and primed.

I. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Cathodically protected piping penetration to buildings and watertight structures.
   c. Submerged to unsubmerged metallic piping connections.
   d. Where required for electrically insulated connection.

2. Pipe Installation:
   a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
   b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   c. Align and install insulating joints as shown on Drawings and according to manufacturer’s recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.11 THRUST RERAINT

A. Location:

1. Buried Piping: Where shown and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations where unbalanced forces exist because of hydrostatic testing and normal operating pressure.
2. Exposed Piping: At all joints in piping.
B. Thrust Ties:

1. Steel Pipe: Attach with lugs fabricated in accordance with details shown on Drawings.
2. Ductile Iron Pipe: Attach with socket clamps anchored against grooved joint coupling or flange.
3. Flanged Coupling Adapters: For exposed installations, install manufacturer’s anchor studs through coupling sleeve or use dismantling joints.

C. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer’s adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

D. Thrust Blocking:

1. Place between undisturbed ground and fitting to be anchored.
2. Quantity of Concrete: Sufficient to cover bearing area on pipe and provide required soil bearing area as shown.
3. Place blocking so that pipe and fitting joints will be accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.12 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Application and Installation: As specified in Section 40 27 01, Process Piping Specialties.

3.13 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheet.
3. Limitations: Threaded taps in pipe barrel are unacceptable.
3.14 VENTS AND DRAINS
A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines at all low and high point locations.

3.15 INSULATION
A. See Section 40 42 13, Process Piping Insulation.

3.16 DISINFECTION
A. See Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

3.17 FIELD FINISHING
A. Notify Engineer at least 3 days prior to start of surface preparation or coating application work.
B. As specified in Section 09 90 00, Painting and Coating.

3.18 PIPE IDENTIFICATION
A. As shown on Piping Schedule as shown on Drawings.

3.19 FIELD QUALITY CONTROL
A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.
B. Minimum Duties of Welding Inspector:
   1. Job material verification and storage.
   2. Qualification of welders.
   3. Certify conformance with approved welding procedures.
   4. Maintenance of records and preparation of reports in a timely manner.
   5. Notification to Engineer of unsatisfactory weld performance within 24 hours of weld test failure.
C. Required Weld Examinations:
   1. Perform examinations in accordance with Piping Code, ASME B31.3 for Normal Fluid Service.
   2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.

4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

D. Test containment piping leak detection system in accordance with system manufacturer’s instructions and recommendations to verify proper operation.

3.20 MANUFACTURER’S SERVICES

A. Provide manufacturer’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, to assist with unloading of the double wall containment piping system, system tests, containment pipe joint closure, installation and testing of leak detection system, and training of Owner’s personnel in operation and maintenance of leak detection system. Manufacturer’s representative shall complete a Manufacturer’s Certificate of Proper Installation. Inspection and examination practices shall be according to ASME B31.3 for Normal Fluid Service.

3.21 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris plant process air and instrument air lines with compressed air at 4,000 fpm; do not flush with water.

C. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

D. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

E. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.
3.22 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this Specification:

1. Data Sheets.

<table>
<thead>
<tr>
<th>Number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 27 00.01</td>
<td>Cement-Mortar, Glass, and Epoxy-Lined Ductile Iron Pipe and Fittings</td>
</tr>
<tr>
<td>40 27 00.02</td>
<td>Carbon Steel Pipe and Fittings—Special Service</td>
</tr>
<tr>
<td>40 27 00.03</td>
<td>Carbon Steel Pipe and Fittings—General Service</td>
</tr>
<tr>
<td>40 27 00.07</td>
<td>Galvanized Steel Pipe and Malleable Iron Fittings</td>
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<tr>
<td>40 27 00.08</td>
<td>Stainless Steel Pipe and Fittings—General Service</td>
</tr>
<tr>
<td>40 27 00.09</td>
<td>Stainless Steel Pipe and Fittings—Special Service</td>
</tr>
<tr>
<td>40 27 00.10</td>
<td>Polyvinyl Chloride (PVC) Pipe and Fittings</td>
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<td>40 27 00.13</td>
<td>Copper and Copper Alloy Pipe Tubing and Fittings</td>
</tr>
<tr>
<td>40 27 00.14</td>
<td>PVC Tubing Inside HDPE Containment Pipe</td>
</tr>
<tr>
<td>40 27 00.15</td>
<td>Double Wall Containment Piping</td>
</tr>
<tr>
<td>40 27 00.21</td>
<td>High Density Polyethylene (HDPE) Pressure Pipe and Fittings</td>
</tr>
<tr>
<td>40 27 00.22</td>
<td>Polyethylene (PE) Piping for Compressed Air and Service</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 40 27 00.01
CEMENT-MORTAR, GLASS, AND EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).</td>
</tr>
<tr>
<td>Pipe</td>
<td>Buried Liquid Service Using Mechanical or Proprietary Restrained Joints: AWWA C111/A21.11, and AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Buried Air Service Using Mechanical or Proprietary Restrained Joints: AWWA C151/A21.51, pressure class conforming to Table 5 and Table 7 for Type 4 trench, 250 psi minimum working pressure. Follower glands shall be ductile iron. Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, 250 psi minimum working pressure.</td>
</tr>
<tr>
<td>Fittings</td>
<td>Lined and coated same as pipe. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type,</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.01
CEMENT-MORTAR, GLASS, AND EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td></td>
<td>wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure; Victaulic. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.</td>
</tr>
<tr>
<td>Joints</td>
<td>Mechanical: 250 psi minimum working pressure. Proprietary Restrained: 150 psi minimum working pressure. Clow Corp., Super-Lock; American Cast Iron Pipe Co., Flex-Ring or Lok-Ring; U.S. Pipe, TR Flex. Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic. Flange: Dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed. Branch connections 3 inches and smaller, except from glass-lined pipe, shall be made with service saddles as specified in Section 40 27 01, Process Piping Specialties. Branch connections, 3 inches and smaller from glass-lined pipe shall be made with glass-lined tee with a flanged branch for adapting to branch piping.</td>
</tr>
<tr>
<td>Couplings</td>
<td>Grooved End: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic. Grooved End Adapter Flanges: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536; Victaulic.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.01
CEMENT-MORTAR, GLASS, AND EPOXY-LINED
DUCTILE IRON PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolting</td>
<td>Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer’s standard. Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Mechanical and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Mechanical and Proprietary Restrained Joints; Hot Air Service: EPDM or Viton, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606. Flanged, Water, Sewage and Hot Air Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000. Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.</td>
</tr>
<tr>
<td>Joint Lubricant</td>
<td>Manufacturer’s standard.</td>
</tr>
</tbody>
</table>

END OF SECTION
### SECTION 40 27 00.02
CARBON STEEL PIPE AND FITTINGS—SPECIAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe</strong></td>
<td>All</td>
<td>Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints:</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Screwed:</strong></td>
</tr>
<tr>
<td></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Schedule 80.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Welded:</strong></td>
</tr>
<tr>
<td></td>
<td>2&quot; thru 10&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>12&quot; thru 16&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>18&quot; thru 24&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Grooved:</strong></td>
</tr>
<tr>
<td></td>
<td>2&quot; thru 6&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>8&quot; thru 12&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>14&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or socket-welded; flanged at equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment.</td>
</tr>
<tr>
<td><strong>Fittings</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, conforming to ASME B16.11, Class 2000 or 3000.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.</td>
</tr>
<tr>
<td><strong>Branch Connections</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threadolet or sockolet in conformance with Fittings above and MSS SP-97.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welding tee in accordance with Fittings above.</td>
</tr>
<tr>
<td>Item</td>
<td>Size</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
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<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Flanges</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 socket-weld or threaded, 1/16-inch raised face.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 slip-on or welding neck, 1/16-inch raised face. Weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</td>
</tr>
<tr>
<td>Unions</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, Class 3000, integral ground steel-to-steel seats, meeting the requirements of ASME B16.11 and MSS SP-83.</td>
</tr>
</tbody>
</table>
| Bolting    | All           | Carbon steel ASTM A193/A193M, Grade B7 studs; ASTM A194/A194M, Grade 2H hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M hex head bolts; ASTM A194/A194M, Grade 8M hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Torque bolts per gasket manufacturer recommendations.
## SECTION 40 27 00.02
CARBON STEEL PIPE AND FITTINGS—SPECIAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaskets</td>
<td>All flanges</td>
<td>General Service and Oil/Gas: 1/16-inch-thick compressed nonasbestos composition flat ring type, rated 400 degrees F continuous. Garlock, Blue-Gard 3000; Durlon 7950. Steam Service: 1/8-inch-thick compressed inorganic or carbon fiber with nitrile binder, flat ring type, rated 600 degrees F continuous. Garlock, ST-706; Durlon, Style 8300; Leader Global Technologies, Type 2078.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.03
CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe</strong></td>
<td>All</td>
<td>Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:</td>
</tr>
<tr>
<td></td>
<td>Threaded:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Schedule 80.</td>
</tr>
<tr>
<td></td>
<td>Welded:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2&quot; thru 10&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>12&quot; thru 16&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>18&quot; thru 24&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>Grooved:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; thru 6&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>8&quot; thru 12&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>14&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.03
CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2&quot; &amp; smaller</td>
<td>For Threaded Pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet, ASTM A105/A105M, Class 3000, meeting the requirements of MSS SP-97.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2&quot; &amp; larger</td>
<td>Butt-welding or grooved end tee in conformance with Fittings specified above.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; &amp; smaller</td>
<td>Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 socket-weld or threaded, 1/16-inch raised face.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.03
CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grooved End Adapter Flange</td>
<td></td>
<td>Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.</td>
</tr>
<tr>
<td>Grooved End Mating Flange</td>
<td></td>
<td>AWWA C207, Class D or E, hub or ring type to mate with ASME B16.1, Class 125 cast-iron flange. AWWA C207 Class F hub type or ASTM A105/A105M, ASME B16.5 Class 300 to mate with ASME B16.1 Class 250 cast-iron flange.</td>
</tr>
<tr>
<td>Unions</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded malleable iron, ASTM A197/A197M, integral brass seats, Class 150, meeting the requirements of ASME B16.39.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Flanges: Alloy steel ASTM A193, Grade B heavy hex head or stud bolts; ASTM A194, Grade 2H heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</td>
</tr>
</tbody>
</table>

Bolting All
Flanges: Alloy steel ASTM A193, Grade B heavy hex head or stud bolts; ASTM A194, Grade 2H heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.
## SECTION 40 27 00.03
CARBON STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B heavy hex head or stud bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>1-1/2&quot; &amp; smaller</td>
<td>General Service: 100 percent virgin PTFE Teflon tape.</td>
</tr>
</tbody>
</table>

END OF SECTION
## SECTION 40 27 00.07
### GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Galvanized carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53, Grade B seamless or ERW.</td>
</tr>
<tr>
<td></td>
<td>2&quot; thru 6&quot;</td>
<td>Schedule 80.</td>
</tr>
<tr>
<td></td>
<td>8&quot; thru 12&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td></td>
<td>14&quot;</td>
<td>Standard weight.</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Flanged at valves and equipment, or grooved end meeting requirements of AWWA C606.</td>
</tr>
<tr>
<td><strong>Fittings</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded: 150-pound malleable iron, ASTM A197/A197M, dimensions in accordance with ASME B16.3, galvanized.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Grooved End: Malleable iron ASTM A47/A47M or ductile iron ASTM A536, 250 psi working pressure, grooved ends to accept couplings without field preparation. Victaulic; Anvil International, Inc., Gruvlok.</td>
</tr>
<tr>
<td><strong>Branch Connections</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Tee or reducing tee in conformance with Fittings above, threadolet or wellolet; ASTM A105/ A105M, CL3000, meeting the requirements of MSS SP-97, galvanize after welding.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Branch Same Size as Run: Grooved end tee in accordance with Fittings above.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Branch One or More Sizes Smaller Than Run: Grooved end reducing tee in accordance with Fittings above.</td>
</tr>
<tr>
<td><strong>Flanges</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Galvanized, forged carbon steel, ASTM A105/ A105M, ASME B16.5 Class 150, threaded, raised face.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.07
GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Galvanized, forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150, threaded, raised face. Butt-Welded Systems Blind Flange: Galvanized, forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150, raised face. Grooved End Adapter Flange: Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Victaulic Style 741 or 743; Anvil International, Inc., Gruvlok Figure 7012 or 7013; Shurjoint Model 7041-A. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.</td>
</tr>
<tr>
<td>Unions</td>
<td></td>
<td>Threaded malleable iron, ASTM A197/A197M or ASTM A47/A47M, Class 300, brass to iron seat, meeting the requirements of ASME B16.39, galvanized.</td>
</tr>
<tr>
<td>Couplings</td>
<td></td>
<td>Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536, 250 psi working pressure. Victaulic; Anvil International, Inc., Gruvlok.</td>
</tr>
<tr>
<td>Plugs</td>
<td></td>
<td>Forged carbon steel, ASME B16.11, ASTM A105/A105M, hex head, threaded, galvanized.</td>
</tr>
<tr>
<td>Bolting</td>
<td></td>
<td>Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength. Flanges: Carbon steel ASTM A307, Grade B heavy hex head or stud bolts and ASTM A563, Grade A heavy hex head nuts. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.07
GALVANIZED STEEL PIPE AND MALLEABLE IRON FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaskets</td>
<td>All flanges</td>
<td>Flanged, Water and Sewage Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F. continuous and conforming to ASME B16.21, ASTM D1330, Steam Grade. Insulating Gasket ASME B16.21 and ASME 16.5, fabric reinforced phenolic neoprene faced gasket, sleeves, washers, CL150, 1/8-inch thick, 175 degrees F Step-Ko Type ‘E’ DW or approved equal.</td>
</tr>
<tr>
<td></td>
<td>Grooved end couplings</td>
<td>EPDM or chlorinated butyl per ASTM D2000 for water, and air to 230 degrees F, dimensions conforming to AWWA C606.</td>
</tr>
<tr>
<td>Thread</td>
<td>1-1/2” &amp; smaller</td>
<td>Teflon tape or joint compound that is insoluble in water.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
## SECTION 40 27 00.08
STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipe</strong></td>
<td>2-1/2&quot; &amp; smaller</td>
<td>Schedule 40S: ASTM A312/A312M, Type 304/304L seamless, pickled and passivated. Schedule 80S if threaded.</td>
</tr>
<tr>
<td></td>
<td>3&quot; thru 6&quot;</td>
<td>Schedule 10S: ASTM A312/A312M, Type 304/304L, pickled and passivated.</td>
</tr>
<tr>
<td></td>
<td>8&quot; &amp; larger</td>
<td>Schedule 5S: ASTM A312/A312M, Type 304/304L, pickled and passivated.</td>
</tr>
<tr>
<td><strong>Joints</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded or flanged at equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment.</td>
</tr>
<tr>
<td><strong>Fittings</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Threaded: MSS SP-114, forged Class 1,000, ASTM A182/A182M, Grade F304 or cast Class 150, ASTM A351/A351M, Grade CF8.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; 2-1/2&quot;</td>
<td>Butt-Welded: ASTM A403/A403M, Grade WP304/304L conforming to ASME B16.9, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.</td>
</tr>
<tr>
<td></td>
<td>3&quot; &amp; larger</td>
<td>Butt-Welded: ASTM A403/A403M, Type 304/304L pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows, unless shown otherwise.</td>
</tr>
<tr>
<td><strong>Branch Connections</strong></td>
<td>1-1/2&quot; &amp; smaller</td>
<td>Tee or reducing tee in conformance with fittings above.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welding tee or reducing tee in accordance with fittings above.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.08
STAINLESS STEEL PIPE AND FITTINGS—GENERAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Forged Stainless Steel: ASTM A182/A182M, Grade F304/304L, ASME B16.5 Class 150, threaded, slip-on, blind, or weld neck, raised face. Weld slip-on flanges inside and outside. Weld neck bore to match pipe.</td>
</tr>
<tr>
<td>Unions</td>
<td>2” &amp; smaller</td>
<td>Threaded Forged: ASTM A182/A182M, Grade F304/F316, CL3000, integral ground seats, AAR design meeting the requirements of MSS SP-83.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Forged Flanges: Type 316 stainless steel, ASTM A320/A320M Grade B8M heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Van Stone Flanges and anywhere mating flange on equipment is cast iron and gasket is flat ring: Carbon steel ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All Flanges</td>
<td>Flanged, Mating Flange is Flat Face: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated to 250 degrees F continuous and conforming to ASME B16.21 and ASTM D1330, Steam Grade. Flanged, Raised Face: 1/8-inch thick ring type, compressed fiber with EPDM binder, ASME B16.21.</td>
</tr>
<tr>
<td>Item</td>
<td>Size</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Thread Lubricant</td>
<td>2&quot; &amp; smaller</td>
<td>General Service: 100 percent virgin PTFE Teflon tape.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.09

### STAINLESS STEEL PIPE AND FITTINGS—SPECIAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>ASTM A312/A312M Type 304/304L seamless annealed, pickled and passivated.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; smaller</td>
<td>Schedule 40S. Schedule 80S if threaded.</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; thru 8&quot;</td>
<td>Schedule 10S.</td>
</tr>
<tr>
<td></td>
<td>8&quot; &amp; larger</td>
<td>Schedule 5S.</td>
</tr>
<tr>
<td>Pipe Joints</td>
<td>3/4&quot; &amp; smaller</td>
<td>Threaded or flanged at equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>1&quot; &amp; 1-1/2&quot;</td>
<td>Socket weld or flanged at equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt-welded or flanged at valves and equipment as required or shown.</td>
</tr>
<tr>
<td></td>
<td>1&quot; and 1-1/2&quot;</td>
<td>Socket Weld Forged: ASTM A182/A182M, Grade F304/304L, CL3000, ASME B16.11.</td>
</tr>
<tr>
<td></td>
<td>2&quot; &amp; larger</td>
<td>Butt Welded: ASTM A403/A403M, Grade WP304/304L conforming to ASME B16.9, annealed, pickled and passivated; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.</td>
</tr>
<tr>
<td>Pipe Branch Connections</td>
<td>2&quot; &amp; smaller</td>
<td>Tee or reducing tee in conformance with fittings above.</td>
</tr>
<tr>
<td></td>
<td>2-1/2&quot; &amp; larger</td>
<td>Butt-Welded Tee or Reducing Tee: In accordance with fittings above forged weldolet or sockolet, Class 3000-pound, ASTM A182/A182M, Grade F304/304L, wall thickness to match adjoining pipe. Meeting requirements of MSS SP-97.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Forged: ASTM A182/A182M Grade F304/304L, ASME B16.5 Class 150, slip-on, blind, threaded, or welding neck, raised face. Weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.</td>
</tr>
</tbody>
</table>
### SECTION 40 27 00.09
STAINLESS STEEL PIPE AND FITTINGS—SPECIAL SERVICE

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unions</td>
<td>3/4&quot; &amp; smaller</td>
<td>Threaded Forged: ASTM A182/A182M, Grade F304, Class 3000, integral ground seats, AAR design meeting requirements of MSS SP-83.</td>
</tr>
<tr>
<td></td>
<td>1&quot; &amp; 1-1/2&quot;</td>
<td>Socket Weld Forged: ASTM A182/A182M Grade F304/304L, Class 3000, integral ground seats, AAR design meeting requirements of MSS SP-83.</td>
</tr>
</tbody>
</table>
| Bolting         | All                | General Conditions: Type 316 stainless steel, ASTM A193/A193M, Grade B8M heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.  
When mating flange on valve or equipment is cast iron and gasket is flat ring, provide ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A heavy hex nuts and ASTM F436/F436M hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. |
| Gaskets         | All Flanges        | 1/16-inch-thick virgin Teflon or inorganic filled Teflon flat ring type for raised face flanges and full face type for flat face flanges; Garlock or Durlon.                                                                 |

END OF SECTION
# SECTION 40 27 00.10
## POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All</td>
<td>Materials in contact with potable water shall conform to NSF 61 acceptance.</td>
</tr>
<tr>
<td>Pipe</td>
<td>All</td>
<td>Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785. Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Solvent socket weld except where connection to threaded valves and equipment may require future disassembly.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M heavy hex head or stud bolts, ASTM A194/A194M Grade 8M heavy hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Noncorrosive Areas: Carbon steel ASTM A307 Grade B heavy hex head or stud bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.</td>
</tr>
</tbody>
</table>
## SECTION 40 27 00.10
POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
</table>
| Gaskets            | All  | Flat Face Mating Flange: Full faced 1/8-inch-thick ethylene propylene (EPR) rubber.  
|                    |      | Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. |
| Solvent Cement     | All  | Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer, IPS Weld-On 724, “or-equal.” Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water. |
| Thread Lubricant   | All  | Teflon Tape.                                                                                                                                  |

**END OF SECTION**
### SECTION 40 27 00.13  
COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Materials in contact with potable water shall conform to NSF 61 acceptance.</td>
</tr>
<tr>
<td>Tubing</td>
<td>Seamless, conforming to ASTM B88 as follows:</td>
</tr>
<tr>
<td></td>
<td>Buried .................................................. Type K, O50 temper</td>
</tr>
<tr>
<td></td>
<td>All other exposures .............................. Type L, H58 temper</td>
</tr>
<tr>
<td>Fittings</td>
<td>ASTM B75 wrought copper, UNS C12200, H58 temper, socket joint, conforming to ASME B16.22.</td>
</tr>
<tr>
<td>Unions</td>
<td>ASTM B75 wrought copper, UNS C12200, H58 temper, socket joint x male NPT, conforming to MSS SP-104.</td>
</tr>
<tr>
<td>Flanges</td>
<td>Class 150, ASTM B61 bronze, threaded, flat face, conforming to ASME B16.24. Lead free casting when used in potable water service.</td>
</tr>
<tr>
<td>Bolting</td>
<td>ASTM A307, carbon steel, Grade B heavy hex head or stud bolts,</td>
</tr>
<tr>
<td></td>
<td>ASTM A563 Grade A heavy hex head nuts and ASTM F436/</td>
</tr>
<tr>
<td></td>
<td>F436M hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per</td>
</tr>
<tr>
<td></td>
<td>gasket manufacturer recommendations.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>1/16-inch-thick nonasbestos compression type, full face, Cranite, John Manville.</td>
</tr>
<tr>
<td>Solder</td>
<td>Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder.</td>
</tr>
<tr>
<td></td>
<td>Joints Larger Than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to</td>
</tr>
<tr>
<td></td>
<td>ASTM B32 Alloy Grade HB or HN. Do not use cored solder.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
### SECTION 40 27 00.14
PVC TUBING INSIDE HDPE CONTAINMENT PIPE

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC Tubing</td>
<td>Polyvinyl Chloride (PVC) tubing, clear translucent, reinforced with braided polyester as required to withstand a working pressure of 75 psig at 70 degrees F and burst pressure rated for 300 psig minimum. Tubing sizes indicated on Drawings are nominal inside diameter dimensions. No tubing splices are allowed inside of carrier/containment pipe. PVC tubing shall be Ryan Herco Flow Solutions, Model 0512, “or-equal.” Joints shall be spliced together as shown in the Standard Details.</td>
</tr>
<tr>
<td>Joints</td>
<td>Barblock coupling inserts inside expandable tubing with outside closure collar, coupling, and collar constructed of polypropylene or equal material compatible with listed chemical service.</td>
</tr>
<tr>
<td>Carrier/Containment Pipe</td>
<td>HDPE, in accordance with Section 40 27 00.21, High Density Polyethylene (HDPE) Pressure Pipe and Fittings, and the Piping Schedule on Drawings.</td>
</tr>
<tr>
<td>Conduit Pipe Joints</td>
<td>Long radius bends. Fusion weld except where connections to threaded valves and equipment may require future disassembly.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
### SECTION 40 27 00.15
DOUBLE WALL CONTAINMENT PIPING

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Containment Pipe</td>
<td>Polyvinyl Chloride (PVC): Schedule 80 ASTM D1785 PVC1120. Pipe shall be spaced from carrier pipe using manufacturer provided spacers. Spacers shall be the nonsolid type and shall not seal the annular space between the carrier pipe and containment pipe. Acceptable Manufacturers: Asahi-America and Georg Fischer.</td>
</tr>
<tr>
<td>Containment Pipe</td>
<td>Joints shall be part of a manufactured system for double contained pipe. Valves shall be double contained within a manufactured enclosure compatible with the containment pipe. Acceptable Manufacturers: Asahi-America and Georg Fischer. A single manufacturer shall be used for each piping system. Do not mix components from multiple manufacturers within a piping system. Refer to Section 40 27 00.10, Polyvinyl Chloride (PVC) Pipe and Fittings Data Sheet, for solvent cement and other joint requirements.</td>
</tr>
<tr>
<td>Leak Detection System</td>
<td>Provide leak detection system as detailed on Drawings. Provide double contained fittings as shown.</td>
</tr>
</tbody>
</table>

END OF SECTION
## SECTION 40 27 00.21
### HIGH DENSITY POLYETHYLENE (HDPE) PRESSURE PIPE AND FITTINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe</td>
<td>All</td>
<td>HDPE: Conforming to Iron Pipe Size (IPS) dimensions, and in compliance with NSF 61. Shall meet or exceed requirements of ASTM D3350 for PE 4710 material with cell classification of 445474C, or better. Pressure rating shall be based on hydrostatic design stress of 1,000 psi at 73.4 degrees F. Pressure Rating: 200 psig and nominal SDR of 11.0.</td>
</tr>
<tr>
<td>Fittings</td>
<td>All</td>
<td>HDPE as specified under Pipe above. All pressure fittings shall be injection molded below 8 inches. For sizes above 8 inches, use thermal butt fusion. Fittings shall have same or higher pressure rating as pipe.</td>
</tr>
<tr>
<td>Joints</td>
<td>All</td>
<td>Butt Fusion: Temperatures, times, and pressures of fusion shall be according to the manufacturer. Pipe joining equipment shall be provided by the pipe and fitting manufacturer. Transition to Threaded Stainless Steel: 2-inch and smaller transition between HDPE and stainless steel pipe, utilize a male threaded transition fitting with male NPT threaded Type 304 stainless steel and HDPE butt fusion end connections.</td>
</tr>
<tr>
<td>Flanges</td>
<td>All</td>
<td>Stub end and polyethylene coated steel backing ring with ASME B16.5 Class 150 bolt pattern. Follow manufacturer’s torque and tightening procedures.</td>
</tr>
<tr>
<td>Bolting</td>
<td>All</td>
<td>ASTM A193/A193M Type 316 stainless steel Grade B8M heavy hex head or stud bolts and ASTM A194/A194M Grade 8M heavy hex head nuts. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket and flange manufacturer recommendations.</td>
</tr>
<tr>
<td>Gaskets</td>
<td>All</td>
<td>Shall be low torque, full face to ASME B16.5 Class 150 dimensions and shall have two concentric, convex, molded rings between center hole and bolt hole circle in flange.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
<table>
<thead>
<tr>
<th>Item</th>
<th>Size</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>All</td>
<td>Piping shall be specifically listed for compressed air service by piping manufacturer. Pipe lengths and fitting connections to be joined by socket fusion; shall be of the same type, grade, and class of polyethylene compound and supplied from same raw material supplier. Pipe tubing and fittings manufactured in accordance with ASTM D2239.</td>
</tr>
<tr>
<td>Pipe</td>
<td>1/2” to 4”</td>
<td>The resin shall be PE100, Solvay Eltex TUB 124 blue high density polyethylene material according to ASTM D3350. Piping shall be based on an SDR* system and calculated utilizing a Hydrostatic Design Basis according to ASTM D2837. Design Stress Rating: 1,600 psi hydrostatic. Pipe shall have a pressure rating of 230 psi at 68 degrees F in all sizes. Identification: Material must be colored coded blue for identification. *SDR: standard dimension ratio = OD/thickness</td>
</tr>
<tr>
<td>Fittings</td>
<td>4” &amp; smaller</td>
<td>Injected molded fittings, socket fusion joined, conforming to ASTM D2657. Transition to metallic piping shall be a nickel-plated male pipe adapter from same manufacturer as piping.</td>
</tr>
<tr>
<td>Manufacturer</td>
<td></td>
<td>Asahi/America; Air Pro.</td>
</tr>
</tbody>
</table>

**END OF SECTION**
SECTION 40 27 01
PROCESS PIPING SPECIALTIES

PART 1  GENERAL

1.01  REFERENCES
A.  The following is a list of standards which may be referenced in this section:

1.  American Society of Mechanical Engineers (ASME):
2.  American Water Works Association (AWWA):
   c.  C210, Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   d.  C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e.  C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
3.  ASTM International (ASTM):
5.  NSF International (NSF):
   a.  NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b.  NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02  SUBMITTALS
A.  Action Submittals:
   1.  Manufacturer’s data on materials, construction, end connections, ratings, overall lengths, and live lengths (as applicable).
   2.  Metal Bellows Field Finishing:
      a.  Manufacturer’s recommended weld procedures for joining welded carbon steel piping to stainless steel bellows.
b. Welder qualifications for joining welded carbon steel piping to stainless steel bellows.

c. Product data for field-applied System No. 4, high temperature, epoxy lining and coating in accordance with Section 09 90 00, Painting and Coating.

3. Chemical Injectors:
   a. Type, size, quantity, materials, and model number of each.
   b. Sketch of each showing major parts, main pipe, and dimensions.
   c. Details and model number of each support system and component.
   d. Details and model of connects (for example, service saddle, weld-o-let).

B. Informational Submittals:

   1. Coupling Harness:
      a. Details, ratings, calculations and test reports for thrust restraints relying on welded bars or rings.
      b. Weld procedure qualifications.
      c. Load proof-testing report of prototype restraint for any size coupling.

   2. Basket Strainer:
      a. Manufacturer’s written/printed installation instructions.
      b. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

C. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide required piping specialty items, whether shown or not shown on Drawings, as required by applicable codes and standard industry practice.

B. Rubber ring joints, mechanical joints, flexible couplings, and proprietary restrained ductile iron pipe joints are considered flexible joints; welded, screwed, and flanged pipe joints are not considered flexible.

C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the
maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 CONNECTORS

A. Teflon Bellows Connector:

1. Type: Two convolutions, unless otherwise shown, with metal reinforcing bands.
2. Flanges: Ductile iron, drilled 150 psi ASME B16.5 standard.
3. Working Pressure Rating: 140 psi, minimum, at 120 degrees F.
4. Thrust Restraint: Limit bolts to restrain force developed by specified test pressure.
5. Manufacturers and Products:
   a. Garlock; Style 214.
   b. Resistoflex; No. R6904.
   c. Unisource Manufacturing, Inc.; Style 112.
   d. Proco Products, Inc.; Series 442.

B. Elastomer Bellows Connector:

1. Type: Fabricated spool, with single filled arch.
5. Thrust Restraint: Control rods to limit travel of elongation and compression.
6. Manufacturers and Products:
   b. Garlock; Style 204.
   c. Unisource Manufacturing, Inc.; Style 1501.
   d. Proco Products, Inc.; Series 220.

C. Metal Bellows Connector:

2. Material: Type 316 stainless steel.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.
5. Length: Minimum of four convolutions and minimum manufacturer recommendation for vibration isolation.

6. Manufacturers and Products:
   b. Metraflex; Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

D. Flexible Metal Hose Connector:

1. Type: Close pitch, annular corrugated with single braided jacket.
3. End Connections: Female copper solder joint.
4. Minimum Burst Pressure: 500 psig at 70 degrees F.
5. Length: Minimum manufacturer recommendation for vibration isolation.

6. Manufacturers and Products:
   b. Anamet Industrial, Inc.
   c. Unisource Manufacturing, Inc.
   d. Proco Products, Inc.

E. Closure Collar Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

F. Quick Connect Couplings for Chemical Services:

1. Type: Twin cam arm actuated, male and female, locking, for chemical loading and transfer.
2. Materials: Glass-filled polypropylene or PVDF with EPDM, Viton-A or Teflon gaskets as recommended for the service by manufacturer.
3. End Connections: NPT threaded or flanged to match piping connections. Hose shank for chemical installations.
4. Plugs and Caps: Female dust cap for each male end; male dust plug for each female end.
5. Pressure Rating: 125 psi, minimum, at 70 degrees F.
6. Manufacturers and Products:
   a. OPW; Kamlock.
   b. Ryan Herco; 1300 Series.

2.03 COUPLINGS

A. General:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. Couplings shall be rated for working pressure not less than indicated in Piping Schedule for the service and not less than 150 psi.

3. Couplings shall be lined and coated with fusion-bonded epoxy in accordance with AWWA C213.

4. Unless thrust restraint is provided by other means, couplings shall be harnessed in accordance with requirements of AWWA Manual M11 or as shown on Drawings.

5. Sleeve type couplings shall conform to AWWA C219 and shall be hydraulically expanded beyond minimum yield for accurate sizing and proofing of tensile strength.

B. Flanged Coupling Adapter:

1. Anchor studs where required for thrust restraint.

2. Manufacturers and Products:
   a. Steel Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 913.
   b. Ductile Iron Pipe:
      1) Dresser Piping Specialties; Style 128.
      2) Smith-Blair, Inc.; Style 912.

C. Restrained Flange Adapter:

1. Pressure Rating:
   b. Safety Factor: Not less than two times working pressure and shall be supported by manufacturer’s proof testing.

2. Thrust Restraint:
   a. Provide hardened steel wedges that bear against and engage outer pipe surface, and allow articulation of pipe joint after assembly while wedges remain in their original setting position on pipe surface.
   b. Products employing set screws that bear directly on pipe will not be acceptable.


D. Restrained Dismantling Joints:

1. Pressure Rating:
   a. Minimum working pressure rating shall not be less than rating of the connecting flange.
   b. Proof testing shall conform to requirements of AWWA C219 for bolted couplings.
2. Manufacturers and Products:
   a. Dresser Piping Specialties; Style 131.
   b. Smith Blair, Inc.; Model 975.

2.04 EXPANSION JOINTS

A. Elastomer Bellows:

1. Type: Reinforced molded wide arch.
2. End Connections: Flanged, drilled 125-pound ASME B16.1 standard, with split galvanized steel retaining rings.
3. Washers: Over retaining rings to help provide leak-proof joint under test pressure.
4. Thrust Protection: Control rods to protect the bellows from overextension.
5. Bellows Arch Lining: Buna-N, nitrile, or butyl.
6. Rated Temperature: 250 degrees F.
7. Rated Deflection and Pressure:
   b. Burst Pressure: Four times the working pressure.
   c. Compression deflection and minimum working pressure as follows:

<table>
<thead>
<tr>
<th>Size (inch)</th>
<th>Deflection (inch)</th>
<th>Pressure (psig)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1/2 to 12</td>
<td>1.06</td>
<td>150</td>
</tr>
<tr>
<td>14</td>
<td>1.65</td>
<td>130</td>
</tr>
<tr>
<td>16 to 20</td>
<td>1.65</td>
<td>110</td>
</tr>
</tbody>
</table>

8. Manufacturers and Products:
   a. General Rubber Corp.; Style 1015 Maxijoint.
   b. Mercer; Flexmore Style 450.
   d. Unisource Manufacturing, Inc.; Series 1500.
   e. Proco Products, Inc.; Series 251.

B. Metal Bellows:

1. Type: Single-ply, annular corrugated metal bellows with limit rods.
   Circumferential convolution welds not permitted.
2. Material: Type 316 stainless steel.
4. Minimum Design Working Pressure: 50 psig at 300 degrees F.

6. Manufacturers and Products:
   b. Metraflex, Model MN.
   c. Senior Flexonics Pathway, Inc.; Expansion Joints.

C. Copper Pipe Expansion Compensator:
   1. Material: Stainless steel bellows with female copper solder joint ends.
   3. Accessories: Anti-torque device to protect bellows.
   4. Manufacturers and Products:
      a. Senior Flexonics; Model HB.
      b. Hyspan; Model 8510.
      c. Unisource Manufacturing, Inc.; Style EC-FFS.

2.05 FLEXIBLE EXPANSION JOINTS

A. Design:
   1. Ball and socket type for earth settlement compensation.
   2. Joints shall be double ball assemblies rated for 15-degree minimum deflection and not less than 4 inches offset from centerline of connecting piping.
   3. Assembly shall accommodate up to 4 inches of expansion in length.
   4. Ductile iron conforming to AWWA C153/A21.53.
   5. Rated for 350 psi.
   6. Components shall be lined and coated by manufacturer with fusion-bonded epoxy on all surfaces not bearing gaskets.
   7. End Connections: Flanged or mechanical joint as shown and as required by connecting pipe and fittings.
   8. Joint connecting to mechanical joint shall be thrust restrained.
   9. Bonding:
      a. Manufacturer shall factory install thermite welded joint bonds for assembled expansion joint.
      b. Provide 24-inch bond wires for field bonds to adjacent metallic piping.
      c. Bond wires shall be 2 AWG with two 12-inch-long THHN insulated 12 AWG wire pigtails.

B. Manufacturer and Product: EBAA Iron Sales Co.; Flex-Tend.
2.06 SEAL WATER HOSE

A. Product as specified for water hose, except 3/8 inch with male NPT ends, in 2-foot lengths.

2.07 SERVICE SADDLES

A. Double-Strap Iron:
   1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
   2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
   4. Materials:
      a. Body: Malleable or ductile iron.
      b. Straps: Galvanized steel.
      c. Hex Nuts and Washers: Steel.
      d. Seal: Rubber.
   5. Manufacturers and Products:
      a. Smith-Blair; Series 313 or 366.
      b. Dresser; Style 91.

B. Nylon-Coated Iron:
   1. Pressure Rating: Capable of withstanding 150 psi internal pressure without leakage or over stressing.
   2. Run Diameter: Compatible with outside diameter of pipe on which saddle is installed.
   3. Materials:
      b. Seal: Buna-N.
      c. Clamps and Nuts: Stainless steel.
   4. Manufacturer and Product: Smith-Blair; Style 315 or 317.

2.08 OUTLET/TAPPING SADDLES

A. Materials:
   2. Seal: O-Ring SBR rubber gasket.
   3. Compatible with ductile iron pipe.

B. Connection: AWWA C110/A21.10 flange or mechanical joint outlet as shown.
C. Pressure Rating: Capable of withstanding 250 psi internal pressure without leakage over stressing.

D. Manufacturer and Product: American Ductile Iron; Outlet/Tapping Saddle.

2.09 PIPE SLEEVES

A. Steel Pipe Sleeve:
   1. Minimum Thickness: 3/16 inch.
   2. Seep Ring:
      a. Center steel flange for water stoppage on sleeves in exterior or water-bearing walls, 3/16-inch minimum thickness.
      b. Outside Diameter: Unless otherwise shown, 3 inches greater than pipe sleeve outside diameter.
      c. Continuously fillet weld on each side all around.
   3. Factory Finish:
      a. Galvanizing:
         1) Hot-dip applied, meeting requirements of ASTM A153/A153M.
         2) Electroplated zinc or cadmium plating is unacceptable.
      b. Shop Lining and Coating: Factory prepare, prime, and finish coat in accordance with Section 09 90 00, Painting and Coating.

B. Molded Polyethylene Pipe Sleeve:
   1. Molded HDPE with integral water stop ring not less than 3 inches larger than sleeve.
   2. Provided with end caps for support during concrete placement.
   3. Manufacturer and Product: Century-Line, Model CS sleeves as manufactured by PSI-Thunderline/Link-Seal.

C. Insulated and Encased Pipe Sleeve:
   1. Manufacturer and Products: Pipe Shields, Inc.; Models WFB, WFB-CS and -CW Series, as applicable.

D. Modular Mechanical Seal:
   1. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
   2. Fabrication:
      a. Assemble interconnected rubber links with ASTM A276, Type 316 stainless steel bolts and nuts.
      b. Pressure plates shall be reinforced nylon polymer.
3. Size: According to manufacturer’s instructions for size of pipes shown to provide a watertight seal between pipe and wall sleeve opening, and to withstand a hydrostatic head of 40 feet of water.

2.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Ductile Iron Wall Pipe:
1. Diameter, Lining, and Ends: Same as connecting ductile iron pipe.
2. Thickness: Equal to or greater than remainder of pipe in line.
3. Fittings: In accordance with applicable pipe data sheet.
4. Thrust Collars:
   a. Rated for thrust load developed at 250 psi.
   b. Safety Factor: 2, minimum.
   c. Material and Construction: Ductile iron or cast iron, cast integral with wall pipe wherever possible, or thrust rated, welded attachment to wall pipe.
5. Manufacturers:
   a. American Cast Iron Pipe Co.
   b. U.S. Pipe and Foundry Co.

B. Steel or Stainless Steel Wall Pipe:
1. Same material and thickness as connecting pipe, except 1/4-inch minimum thickness.
2. Lining: Same as connecting pipe.
3. Thrust Collar:
   a. Outside Diameter: Unless otherwise shown, 3 inches greater than outside diameter of wall pipe.
   b. Continuously fillet welded on each side all around.

2.11 CHEMICAL INJECTOR SYSTEM

A. Chemical Injectors:
1. Type, size, quantity, and materials as shown on Drawings and Standard Details.
2. Manufacturer: SAF-T-FLO.

B. Support System:
1. Stainless steel Unistrut or FRP Aickenstrut.
2. Materials compatible with chemical service and subject to Engineer approval.
C. Connectors: Stainless steel service saddle or weld-o-let, as shown on Drawings.

2.12 MISCELLANEOUS SPECIALTIES

A. Strainers, Water Service, 2 Inches and Smaller:
   1. Type: Bronze body, Y-pattern, 200 psi nonshock rated, with screwed gasketed bronze cap.
   2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
   3. Manufacturers and Products:
      a. Armstrong International; Inc.; Model F.
      b. Mueller Steam Specialty; Model 351M.

B. Strainers, Water Service, 2-1/2 Inches and Larger:
   1. Type: Cast iron or ductile iron body, Y-pattern, 175 psi nonshock rated, with flanged gasketed iron cap.
   2. Screen: Heavy-gauge Type 316 stainless steel, 0.045-inch perforations.

C. Strainers, Plastic Piping Systems, 4 Inches and Smaller:
   1. Type: Y-pattern PVC body, 150 psi nonshock rated, with screwed PVC cap and Viton seals.
   2. End Connections: Screwed or solvent weld, 2 inches and smaller. Class 150 ANSI flanged, 2-1/2 inches and larger.
   3. Screen: Heavy-gauge PVC, 1/32-inch mesh, minimum 2 to 1 screen area to pipe size ratio.
   4. Manufacturer: Hayward.

D. Water Hose:
   1. Furnish 50-foot lengths of 1-inch and 50-foot lengths of 1-1/2-inch rubber hose. EPDM black cover and EPDM tube, reinforced with two textile braids. Provide each length with brass male and female NST hose thread couplings to fit hose nozzle and hose valve.
   2. Rated minimum working pressure of 200 psi.
   3. Manufacturers:
      a. Goodyear.
      b. Boston.
E. Hose Nozzles:

1. Furnish 1-inch and 1-1/2-inch cast brass, satin finish, nozzles with adjustable fog, straight-stream, and shut-off feature and rubber bumper. Provide nozzles with female NST hose thread.

2. Manufacturers:
   a. Croker.
   b. Elkhart.

F. Pump Seal Water Sight Flow Indicators:

2. Rated 125 psi with NPT screwed ends.
3. Operate with a minimum flow of 0.25 gpm.
4. Manufacturers and Products:
   b. Jacoby Tarbox Co.

G. Inline Static Mixers:

1. Wafer style mixer.
2. Provide chemical mixing with a maximum pressure drop of 2.5 psi at 900 gpm design capacity.
3. Mixer housing and elements shall be fabricated in materials fully chemically compatible with the applied chemicals per table below.
4. Mixer body shall be designed for mounting between two standard pipe flanges and shall include one 1/2-inch FNPT additive port with injection orifice at the point of highest induced turbulence.
5. Inline Static Mixer Table:

<table>
<thead>
<tr>
<th>Mixer Location</th>
<th>Applied Chemical at Mixer</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Water (Pre-oxidized)</td>
<td>50% Aluminum Chlorohydrate</td>
<td></td>
</tr>
<tr>
<td>Finished Water</td>
<td>0.8% Sodium Hypochlorite</td>
<td>Phosphoric acid and/or Sodium Hydroxide can be applied immediately upstream of mixer.</td>
</tr>
</tbody>
</table>

6. Manufacturer and Product:
   a. Komax; Model WF-73717.
   b. “Or-equal.”
H. Valve Vault Sump Pump (I10P0013):

1. Type: Submersible solids handling pump.
2. Volute: Cast-iron, foot mounted.
7. Shaft: Stainless steel.
9. Electrical: Attached power and control cables, 20 feet long, 120V.
10. Controls:
    a. Level Control: Polypropylene-encapsulated mechanical float switch. Shut off pump at low level.
    b. Pump start and shutdown, local control only.
11. Manufacturer and Product:
    a. Hydromatic; SHEF42.
    b. “Or-equal.”

I. Secondary Chemical Containment:

1. Sodium Permanganate, Sodium Hydroxide, Citric Acid, Phosphoric Acid, Calcium Thiosulfate, Sulfuric Acid:
   b. Minimum Weight Capacity: 1,500 pounds.
   c. Maximum Height: 18 inches.
   d. Material of Construction: Polyethylene.
   e. Manufacturer and Product:
      1) Eagle; 1620.
      2) “Or-equal.”
   f. Provide one loading ramp at each facility, compatible with the selected secondary chemical containment.
2. Aluminum Chlorohydrate:
   b. Minimum Weight Capacity: 8,000 pounds.
   c. Maximum Height: 20 inches.
   d. Material of Construction: Polyethylene.
   e. Manufacturer and Product:
      1) Denios; IBC Poly Storage Sump.
      2) “Or-equal.”
PART 3 EXECUTION

3.01 GENERAL

A. Provide accessibility to piping specialties for control and maintenance.

3.02 PIPING FLEXIBILITY PROVISIONS

A. General:

1. Thrust restraint shall be provided as specified in Section 40 27 00, Process Piping—General.
2. Install flexible couplings to facilitate piping installation, in accordance with approved shop drawings.

B. Flexible Joints at Concrete Backfill or Encasement: Install within 18 inches or one-half pipe diameter, whichever is less, from the termination of any concrete backfill or concrete encasement.

C. Flexible Joints at Concrete Structures: Install 18 inches or less from face of structures; joint may be flush with face.

D. Flexible expansion joints shall be provided to compensate for earth settlement at buried piping connections to structure wall pipes. Wrap complete joint assembly in a double layer of polyethylene encasement, as specified in Section 40 27 00, Process Piping—General.

3.03 PIPING TRANSITION

A. Applications:

1. Provide complete closure assembly where pipes meet other pipes or structures.
2. Pressure Pipeline Closures: Plain end pieces with double flexible couplings, unless otherwise shown.
3. Restrained Joint Pipe Closures: Install with thrust tie-rod assemblies as shown.
4. Gravity Pipe Closures: As specified for pressure pipelines, or concrete closures.
5. Concrete Closures: Use to make connections between dissimilar pipe where standard rubber gasketed joints or flexible couplings are impractical, as approved.
6. Elastomer sleeves bonded to pipe ends are not acceptable.
B. Installation:

1. Flexible Transition Couplings: Install in accordance with coupling manufacturer’s instructions to connect dissimilar pipe and pipes with a small difference in outside diameter.

2. Concrete Closures:
   a. Locate away from structures so there are at least two flexible joints between closure and pipe entering structure.
   b. Clean pipe surface before placing closure collars.
   c. Wet nonmetallic pipe thoroughly prior to pouring collars.
   d. Prevent concrete from entering pipe.
   e. Extend collar a minimum of 12 inches on each side of joint with minimum thickness of 6 inches around outside diameter of pipe.
   f. Make entire collar in one placement.
   g. After concrete has reached initial set, cure by covering with well-moistened earth.

3.04 PIPING EXPANSION

A. Piping Installation: Allow for thermal expansion due to differences between installation and operating temperatures.

B. Expansion Joints:

3. Screwed and Soldered Piping Systems: Copper or galvanized and black steel pipe expansion compensator, as applicable.
4. Air and Water Service above 120 Degrees F: Metal bellows expansion joint.
5. Pipe Run Offset: Flexible metal hose.

C. Weld-End Metal Bellows Installation:

1. Field Weld: Stainless steel bellows beveled ends joined to ALP carbon steel piping in accordance with approved welding procedures.
2. Lining:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
   b. Field apply lining to protect bellows and piping from rust at welded joint.
   c. Line both ends inside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot inside length of the carbon steel pipe.
3. Coating:
   a. System No. 4, high-temperature epoxy, in accordance with Section 09 90 00, Painting and Coating.
   b. Field apply coating to protect bellows and piping from weather and rust at welded joint.
   c. Coat both ends outside bellows, entire length of extension stub end, and from weld joint to a distance of 1 foot outside length of the carbon steel pipe.

D. Anchors: Install as specified in Section 40 05 15, Piping Support Systems, to withstand expansion joint thrust loads and to direct and control thermal expansion.

3.05 SERVICE SADDLES
   A. Ferrous Metal Piping (except stainless steel): Double-strap iron.
   B. Plastic Piping: Nylon-coated iron.

3.06 OUTLET/TAPPING SADDLE
   A. Install in accordance with manufacturer’s written instructions.

3.07 COUPLINGS
   A. General:
      1. Install in accordance with manufacturer’s written instructions.
      2. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
      3. Do not remove pipe coating. If damaged, repair before joint is made.
      4. Application:
         b. Concrete Encased Couplings: Flexible coupling.

3.08 FLEXIBLE PIPE CONNECTIONS TO EQUIPMENT
   A. Install to prevent piping from being supported by equipment, for vibration isolation, and where shown.
   B. Product Applications Unless Shown Otherwise:
      1. Nonmetallic Piping: Teflon bellows connector.
      2. Copper Piping: Flexible metal hose connector.
      3. Compressor and Blower Discharge: Metal bellows connector.
      4. All Other Piping: Elastomer bellows connector.
C. Limit Bolts and Control Rods: Tighten snug prior to applying pressure to system.

3.09 PIPE SLEEVES

A. Application:

1. As specified in Section 40 27 00, Process Piping—General.
3. Belowgrade or in Submerged or Damp Environments: Shop-lined and coated.
4. Alternatively, molded polyethylene pipe sleeve as specified may be applied.

B. Installation:

1. Support noninsulating type securely in formwork to prevent contact with reinforcing steel and tie-wires.
2. Caulk joint with specified sealant in non-submerged applications and seal below grade and submerged applications with wall penetration seal.

3.10 SLAB, FLOOR, WALL AND ROOF PENETRATIONS

A. Applications:

1. Watertight and Below Ground Penetrations:
   a. Wall pipes with thrust collars.
   b. Provide taps for stud bolts in flanges to be set flush with wall face.
3. Existing Walls: Rotary drilled holes.
4. Fire-Rated or Smoke-Rated Walls, Floors or Ceilings: Insulated and encased pipe sleeves.

B. Wall Pipe Installation:

1. Isolate embedded metallic piping from concrete reinforcement using coated pipe penetrations as specified in Section 09 90 00, Painting and Coating.
2. Support wall pipes securely by formwork to prevent contact with reinforcing steel and tie-wires.
3.11 CHEMICAL INJECTOR SYSTEM

A. Install in accordance with manufacturer’s instructions.

END OF SECTION
SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA): 3, Orifice Metering of Natural Gas and Other Related Hydrocarbon Fluids.
3. American Society of Mechanical Engineers (ASME):
4. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. American Water Works Association (AWWA):
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C541, Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
   l. C550, Protective Interior Coatings for Valves and Hydrants.
   m. C606, Grooved and Shouldered Joints.
   n. C800, Underground Service Line Valves and Fittings.
6. ASTM International (ASTM):
   e. B61, Standard Specification for Steam or Valve Bronze Castings.
   f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
   i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.


9. FM Global (FM).

10. Food and Drug Administration (FDA).

11. International Association of Plumbing and Mechanical Officials (IAPMO).

12. Manufacturers Standardization Society (MSS):
    a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
    b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
    c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
    d. SP-88, Diaphragm Valves.
    e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

14. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

15. UL.

16. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.
   d. Power and control wiring diagrams, including terminals and numbers.
   e. For each power actuator provided, manufacturer’s standard data sheet, with application specific features and options clearly identified.
   f. Sizing calculations for open-close/throttle and modulating valves.
   g. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

2. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements, for:
   a. Electric actuators; full compliance with AWWA C542.
   b. Butterfly valves; full compliance with AWWA C504.

3. Component and attachment testing certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

4. Tests and inspection data.

5. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
PHASE IV BEAVER CREEK WATER SUPPLY

6. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.

B. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.

C. Valve same size as adjoining pipe, unless otherwise called out on Drawings or in Supplements.

D. Valve ends to suit adjacent piping.

E. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.

F. Size operators and actuators to operate valve for full range of pressures and velocities.

G. Valve to open by turning counterclockwise, unless otherwise specified.

H. Factory mount operator, actuator, and accessories.

I. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SCHEDULE

A. Additional requirements relative to this section are shown on the Self-Contained Valve Schedule attached as a Supplement to this Section.
2.03 MATERIALS

A. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.

1. Approved alloys are of the following ASTM designations:
   a. B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.

2. Stainless steel Alloy 18-8 may be substituted for bronze.

B. Valve materials in contact with or intended for drinking water service to meet the following requirements:

1. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.

2. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.

3. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.04 FACTORY FINISHING

A. General:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.

2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.

3. Material in contact with potable water shall conform to NSF/ANSI 61.

4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be "safety yellow."

B. Where epoxy lining and coating are specified, factory finishing shall be as follows:

1. In accordance with AWWA C550.

2. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.

3. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.
2.05 VALVES

A. Gate Valves:

1. General:
   a. AWWA gate valves to be in full compliance with stated AWWA standard and the following requirements:
      1) Provide 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller.
      2) Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
      3) Provide Affidavit of Compliance per the applicable AWWA standard for AWWA gate valves.
      4) Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
      5) Repaired AWWA gate valves shall not be submitted or supplied.
      6) Supply AWWA gate valves with stainless steel bolting.
      7) AWWA C509 and AWWA C515 valves may be substituted for each other.

2. Type V134 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
   a. Ductile iron body, resilient seat, bronze stem and stem nut, ASME B16.1 Class 125 flanged ends, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
   b. Manufacturers and Products:
      1) American Flow Control; Series 2500.
      2) M&H; Style 7000 and C515 Large RW Valves.

3. Type V135 Resilient Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
   a. Ductile iron body, resilient seat, bronze stem and stem nut, mechanical joint ends, or mechanical joint by flanged end where indicated, nonrising stem, in accordance with AWWA C515, minimum design working water pressure 200 psig, full port, fusion epoxy coated inside and outside per AWWA C550, NSF/ANSI 61 certified.
   b. Manufacturers and Products:
      1) American Flow Control; Series 2500.
      2) M&H; Style 7000 and C515 Large RW Valves.
B. Globe Valves:

1. Type V200 Globe Valve 3 Inches and Smaller:
   a. All-bronze, union bonnet, packed gland, inside screw, rising stem, TFE disc, Class 150 rated 150 psi SWP/300 psi CWP, complies with MSS SP-80 Type 2.
   b. Manufacturers and Products:
      1) Stockham; Figure B-22T, NPT threaded end.
      2) Crane Co.; Figure 7TF, NPT threaded end.
      3) Milwaukee; Model 1590T, soldered ends.
      4) NIBCO; Figure S-235-Y, soldered ends.

2. Type V208 Needle Disc Type Globe Valve 1/8 Inch to 3/4 Inch:
   a. All-bronze, threaded bonnet, packed gland, rising stem, bronze body and stem, Class 200 rated 200 psi SWP/400 psi CWP, complies with MSS SP-80.
   b. Manufacturers and Products:
      1) Crane Cat.; No. 88.
      2) Stockham; B-64.

C. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
   a. Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip, rated 600-pound WOG, 150-pound SWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Threaded:
         a) Conbraco Apollo; 70-100.
         b) Nibco; T-580-70.
      2) Soldered:
         a) Conbraco Apollo; 70-200.
         b) Nibco; S-580-70.

2. Type V307 Stainless Steel Ball Valve 2 Inches and Smaller:
   a. Three-piece, full port, ASTM A276 GR 316 or ASTM A351/ A351M GR CF8M stainless steel body and end pieces, Type 316 stainless steel ball, NPT threaded ends, reinforced PTFE seats, seals, and packing, adjustable packing gland, blowout-proof stainless steel stem, stainless steel lever operator with vinyl grip, rated 800 psig to 1,000 psig CWP, complies with MSS SP-110.
   b. Manufacturers and Products:
      1) Conbraco Apollo; 86R-100/86-500 Series.
      2) Nibco; T-595-S6-R-66-LL.
3. Type V330 PVC Ball Valve 2 Inches and Smaller:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball, and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball.
   b. For sodium permanganate and sodium hydroxide services, stem seals shall be Teflon.
   c. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.
      3) Spears; True Union.

4. Type V331 PVC Ball Valve 3 Inches and 4 Inches:
   a. Rated 150 psi at 73 degrees F, with ASTM D1784 Type I, Grade 1 PVC full port body, Teflon seat, Viton O-ring stem, face and carrier seals, end entry design with dual union, solvent-weld socket ends, or single union ball valve with flanged ends drilled to ASME B16.1. Provide pressure relief hole drilled on low pressure side of ball.
   b. Manufacturers and Products:
      1) Nibco; Chemtrol Tru-Bloc.
      2) ASAHI/America; Type 21.

D. Plug Valves:

1. Type V400 Eccentric Plug Valve 2 Inches and Smaller:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, threaded ends, lever operator, cast-iron plug with round or rectangular port, plug coated with Buna-N, stem bearing lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber.
   b. Manufacturers and Products:
      1) Pratt; Ballcentric.
      2) DeZurik; Style PEC.
      3) Milliken; Millcentric Series 603.

2. Type V405 Eccentric Plug Valve 3 Inches to 12 Inches:
   a. Nonlubricated type rated 175 psig CWP, drip-tight shutoff with pressure from either direction, cast-iron body, exposed service flanged ends per ASME B16.1 or grooved ends in accordance with AWWA C606 for rigid joints, buried service mechanical joint ends, unless otherwise shown.
b. Plug cast iron with round or rectangular port of no less than 80 percent of connecting pipe area and coated with Buna-N, seats welded nickel, stem bearings lubricated stainless steel or bronze, stem seal multiple V-rings, or U-cups with O-rings of nitrile rubber, grit seals on both upper and lower bearings.

c. For buried service, provide external epoxy coating.

d. Operators:
   1) 3-Inch to 4-Inch Valves: Wrench lever manual.
   2) 6-Inch to 12-Inch Valves: Totally enclosed, geared, manual operator with handwheel, 2-inch nut or chain wheel. Size operator for 1.5 times maximum operating shutoff pressure differential for direct and reverse pressure, whichever is higher. For buried service, provide completely sealed operator filled with heavy lubricant and 2-inch nut.

e. Manufacturers and Products:
   1) Pratt; Ballcentric.
   2) DeZurik; Style PEC.
   3) Milliken; Millcentric Series 600.

3. Type V462 Gauge Cock 1/8 Inch to 1/4 Inch:
   a. 1/4-inch bronze body, hexagon end pattern, tee head, male ends, rated 125-pound SWP.
   b. Manufacturer and Product: United Brass Works; Figure 973.

4. Type V464 Corporation Stop 1/2 Inch to 2 Inches:
   a. AWWA C800 type, tapered threaded inlet, except when connecting to tapped fittings which require IPS tapered threads, outlet compression connection or IPS threads to suit connecting pipe, stops 1 inch and smaller rated 100 psi, larger stops rated 80 psi.
   b. Manufacturers:
      1) Ford Meter Box Co.
      2) Mueller Co.

E. Butterfly Valves:

1. General:
   a. In full compliance with AWWA C504 and following requirements:
      1) Suitable for throttling operations and infrequent operation after periods of inactivity.
      2) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.
      3) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
4) No travel stops for disc on interior of body.
5) Self-adjusting V-type or O-ring shaft seals.
6) Isolate metal-to-metal thrust bearing surfaces from flowstream.
7) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
8) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
9) Provide linings and coatings per AWWA, unless otherwise indicated on Drawings or specified herein.
10) Valves to be in full compliance with NSF/ANSI 61. Provide NSF/ANSI 61 certificate for each valve.

b. Non-AWWA butterfly valves to meet the following actuator requirements:
1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on Drawings or specified herein.

2. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. AWWA C504, Class 150B.
   b. Short body type, flanged ends.
   c. Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, Buna-N EPDM rubber seat bonded or molded in body only, and stainless steel seating surface.
   d. Provide epoxy lining in compliance with AWWA C550.
   e. Manufacturers and Products:
      1) Pratt; Model 2FII or Triton XR-70.
      2) DeZurik; AWWA Valve.

3. Type V502 Butterfly Valve General Service 3 Inches to 20 Inches:
   a. AWWA C504, Class 150B.
   b. Wafer style type.
   c. Buna-N rubber seat.

4. Type V510 Lug Style Butterfly Valve, Resilient Seated, 2 Inches to 20 Inches for Low Pressure Process Air Service:
   a. Lug style cast-iron body, aluminum bronze discs, Type 316 stainless steel one-piece stem, self-lubricating sleeve type bushings, EPDM replaceable resilient seat suitable for operating temperatures up to 250 degrees F, 150 psi working pressure rating, bubble-tight at 50 psi differential pressure, valve body to fit between ASME B16.1 Class 125/150 flanges.
   b. Manufacturers and Products:
      1) Bray Controls; Series 31.
      2) Tyco/Keystone; Model AR2.
5. Type V514 High Performance Butterfly Valve 2 Inches to 36 Inches:
   a. ASME B16.1 Class 150 lug style, high performance type, carbon steel body, Type 316 stainless steel single or double offset disc, Type 316 stainless steel shaft and taper pins, EPDM seat, PTFE stem packing, stainless steel with RTFE thrust washer.
   b. Manufacturers and Products:
      1) Tyco/Keystone; K-Lok Series.
      2) DeZurik; BHP Series.

F. Check and Flap Valves:

1. Type V608 Swing Check Valve 2 Inches to 24 Inches:
   a. AWWA C508, 125-pound flanged ends, cast-iron body, bronze body seat, bronze mounted cast-iron clapper with bronze seat, stainless steel hinge shaft.
   b. Valves, 2 inches through 12 inches rated 175-pound WWP and 14 inches through 24 inches rated 150-pound WWP. Valves to be fitted with adjustable outside lever and weight. Increasing-pattern body valve may be used where increased outlet piping size is shown.
   c. Manufacturers and Products:
      1) M&H Valve; Style 59, 159, or 259.
2. Type V630 PVC Ball Check Valve 4 Inches and Smaller:
   a. ASTM D1784, Type I, Grade 1 polyvinyl chloride body, dual union socket weld ends, rated 150 psi at 73 degrees F, and Viton seat and seal.
   b. For sodium permanganate and sodium hydroxide services, stem seats and seals shall be Teflon.
   c. Manufacturers and Products:
      1) Nibco; Chemtrol Tru Union.
      2) ASAHI/America.
      3) Spears; True Union.
3. Type V692 Flap Valve 4 Inches to 30 Inches:
   a. Flange style frame, cast-iron body, bronze seats on body and cover, bronze hinge pins.
   b. Manufacturers and Products:
      1) M&H Valve; Style 47-02.
      2) Clow Valve; No. F-3012.
4. Type V694 Check Valve 1 Inch to 48 Inches:
   a. Elastomer type flanged or slip-on as shown on Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger, valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition, rated for
50 psi minimum operating pressure; flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced neoprene.

b. Manufacturer and Products: Red Valve Co.; Tideflex Check Valve Series TF-1 or 35-1.

G. Self-Regulated Automatic Valves:

1. Type V710 Pressure-Reducing Valve 2-1/2 Inches and Smaller:
   a. Direct diaphragm operated, spring controlled, lead free brass body, NPT threaded ends, 300-psig rated minimum.
   b. Size/Rating: As shown on the Self-Contained Valve Schedule.
   c. Manufacturer and Product:
      1) Watts; Series LF26A.
      2) “Or-equal.”

2. Type V714 Combination Pressure-Reducing, Solenoid Shut-off and Surge Control Valve 3 Inches and Larger:
   a. Hydraulically operated, diaphragm actuated, pilot controlled globe valve, with solenoid override. Solenoid shall be 120volt, normally open/power to close main valve. Valve shall include a closed limit switch. Ductile iron body, ASME B16.1 Class 150 flanged ends, rated 250 psi, bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks, maintains a constant downstream pressure regardless of fluctuations in flow or upstream pressure.
   b. FDA approved fusion bonded epoxy lining installed in accordance with AWWA C550.
   c. Size/Rating: As shown in Self-Contained Valve Schedule.
   d. Manufacturer and Product:
      1) Cla-Val; 94DG-05BCSYKC with W/X105LCW micro-switch.
      2) “Or-equal.”

3. Type V741 Combination Vacuum Relief/Air Inlet and Air-Release Valve 1/2 Inches to 3 Inches:
   a. The Vacuum Relief/Air Inlet Valve is normally closed. Should the system pressure become negative, the Vacuum Relief/Air Inlet Valve will immediately admit air into the system and prevent a vacuum from forming. When system pressure returns to positive the Vacuum Relief/Air Inlet Valve closes air tight.
   b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512, NPT threaded inlet and plain outlet with protective hood.
c. Equipped with a separate air release valve to allow air to release on return to positive pressure. Air release valve shall be rated for 0 psig to 150 psig operating range with an 0.094-inch outlet orifice.
d. Manufacturer and Product:
   1) APCO Valve and Primer Corp.; Series 1500 TC.
   2) “Or-equal.”

4. Type V742 Air and Vacuum Valve 1/2 Inch to 16 Inches for Vertical Turbine Service:
a. Equip 1/2 inch through 3 inches with stainless steel diffuser screen to break up solid water column before coming in contact with float, manufacturer’s standard double acting throttling device in outlet for throttling, NPT threaded inlet and outlet.
b. Equip 4 inches and larger with anti-slam device to throttle flow of water into air valve. Design anti-slam device to permit full, unrestricted flow of air into and out of air valve, but reduce flow area for water to approximately 10 percent. ASME B16.1 Class 125 flanged inlet and NPT threaded outlet.
c. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
d. Manufacturers and Products:
   1) APCO Valve and Primer Corp.; Series 141DAT to 146DAT or Series 1904 to 1916.
   2) Val-Matic Valve; Series 100WS to 116WS.

5. Type V743 Automatic Degassing Valve:
a. Valve shall be designed to automatically vent vapors that are released from chemical solution in feed lines.
b. Valve shall be constructed of CPVC and Viton with 1/2-inch NPT connection.
c. Valve shall be suitable for 150 psig at 75 degrees F.
d. Manufacturers and Products:
   1) Plast-O-Matic; Series DGV.
   2) Primary Fluid Systems; Accu-Vent.

6. Type V744 Air Release Valve 1/2 Inch to 2 Inches:
a. Suitable for potable water service, automatically exhaust small amounts of entrained air that accumulates in a system. In CLOSED position, seat against resilient seat to prevent water leakage.
b. Rated 150 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, NPT threaded inlet and outlet, built and tested to AWWA C512.
c. Manufacturers and Products:
   1) APCO Valve and Primer Corp.; Series 50, 200, and 200A.
   2) Val-Matic Valve; Series 15A to 45.6.
7. Type V749 PVC Vacuum Breaker/Anti-Siphon Valve:
   a. Self-sealing diaphragm constructed of FKM or Viton, PVC body, 1/2-inch NPT threaded inlet, 100 psi working pressure at 75 degrees F. Begins to break vacuum at approximately 2 inches of mercury.
   b. Manufacturer and Product:
      1) Plast-O-Matic; Series VBM.
      2) “Or-equal.”

2.06 OPERATORS AND ACTUATORS

A. Manual Operators:

1. General:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.
   c. Operator self-locking type or equipped with self-locking device.
   d. Position indicator on quarter-turn valves.
   e. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator’s threaded steel reach rod with internally threaded bronze or ductile iron nut.

2. Exposed Operator:
   a. Galvanized and painted handwheel.
   b. Cranks on gear type operator.
   c. Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
   d. Valve handles to take a padlock, and wheels a chain and padlock.

3. Buried Operator:
   a. Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   b. Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
   c. Buried valves shall have extension stems, bonnets, and valve boxes.
B. Seismic Isolation Valve Control System:

1. General:
   a. Seismic Isolation Valve Control System shall be supplied for valve tag P30FV0003. Actuator shall be supplied as part of a complete seismic system, including actuator, seismic controller, and power supply.
   b. All components in the seismic system shall be supplied by the same manufacturer, and shall be designed to function as a complete system.

2. Actuator:
   a. Electric, 24V dc actuator.
   b. Mounts to 2-inch operating nut of valve.
   c. Size to 1-1/2 times the required operating torque. Motor stall torque not to exceed torque capacity of the valve.
   d. Provide operator mounting bracket to mount operator to valve providing minimal torque to piping system when operating.
   e. Local (at the actuator) OPEN / STOP / CLOSE control and status.
   f. Local (at the actuator) and SCADA security key local/remote position status.
   g. Remote (from seismic controller panel and/or SCADA) OPEN/STOP (in Transition)/CLOSE control and status.
   h. Manufacturer and Product: FLOLOC; FLOPAK.

3. Seismic Controller (P30FP0003):
   a. Panel containing seismic sensor, controls for seismic control actuator, and SCADA interface.
   b. Enclosure: NEMA 4X fiberglass.
   c. Input Power: 120V ac.
   d. Local Interface:
      1) 24V dc power.
      2) Seismic Control Actuator OPEN/CLOSE Commands.
      3) Valve Open/Closed Status.
      4) Valve Transition Status.
      5) Key Switch Status (Actuator local/remote position status).
   e. External interface provided with controller, not all are utilized:
      1) SCADA 24V dc power.
      2) Remote Seismic Sensor Arm/Trip.
      3) Remote Seismic Sensor Arm/Trip Status.
      4) Remote Valve Position Open/Closed Status.
      5) Remote Valve In Transition Status.
      6) Remote Key Switch Status (Actuator local/remote position status).
   f. Manufacturer and Product: FLOLOC; FL-201-1.
4. Power Supply:
   a. Battery based power supply capable of actuating Seismic Control Actuator.
   b. Charge from 120V ac power.
   c. Included in Seismic Controller panel.

2.07 ACCESSORIES

A. Tagging: 1-1/2-inch diameter heavy brass or stainless steel tag attached with
   No. 16 solid brass or stainless steel jack chain for each valve operator, bearing
   valve tag number shown on Drawings.

B. Extension Bonnet for Valve Operator: Complete with enclosed stem,
   extension, support brackets, and accessories for valve and operator.
   1. Manufacturers and Products: Same as valve manufacturer.

C. Floor Stand:
   1. Nonrising, heavy pattern, indicating type.
   2. Complete with solid extension stem, coupling, handwheel, stem guide
      brackets, and yoke attachment. Stem length as required to connect valve
      operating nut and floor stand.
   3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
   4. Anchor Bolts: Type 304 stainless steel.
   5. Manufacturers and Products:
      a. Clow; Figure F-5515.
      b. Mueller, Figure A-26426.

D. Floor Box:
   1. Plain type, for support of nonrising type stem.
   2. Complete with solid extension stem, operating nut, and stem guide
      brackets. Stem length as required to extend valve operating nut to within
      3 inches of finish floor.
   3. Stem Guide: Space such that stem L/R ratio does not exceed 200.
   4. Anchor Bolts: Type 304 stainless steel.
   5. Manufacturers and Products:
      a. Neenah Foundry; R 7506.
      b. Clow; No. F5690.

E. Chain Wheel and Guide:
   1. Handwheel direct-mount type.
   2. Complete with chain.
   3. Galvanized or cadmium-plated.
4. Manufacturers and Products:
   a. Clow Corp.; Figure F-5680.
   b. Walworth Co.; Figure 804.
   c. DeZurik Corp.; Series W or LWG.

F. Indicator Post Assembly:
   1. Cast or ductile iron post head, bell, and wrench with cast or ductile iron or steel barrel.
   2. Plexiglas or equal protected window to indicate OPEN and CLOSED position.
   3. Padlockable eye bolt for wrench.
   5. UL Listed and FM Approved.
   6. Manufacturers and Products:
      a. Clow; Style 2945.
      b. Mueller; A-20806.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:
   1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
   2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:
   1. Clean threads by wire brushing or swabbing.
   2. Apply joint compound.

C. PVC Valves: Install using solvents approved for valve service conditions.

D. Valve Installation and Orientation:
   1. General:
      a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
      b. Install valves in location for easy access for routine operation and maintenance.
      c. Install valves per manufacturer’s recommendations.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.

3. Eccentric Plug Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve as follows:
      1) Liquids with suspended solids service with horizontal flow: Install valve with stem in horizontal position with plug up when valve is open. Install valve with seat end upstream (flow to produce unseating pressure).
      2) Liquids with suspended solids service with vertical flow: Install valve with seat in highest portion of valve (seat up).
      3) Clean Liquids and Gas Service: Install valve with seat end downstream of higher pressure when valve is closed (higher pressure forces plug into seat).

4. Butterfly Valves:
   a. Unless otherwise restricted or shown on Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
   b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
   c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
   d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
   e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.

5. Check Valves:
   a. Install valve in accordance with manufacturer’s instructions and provide required distance from immediate upstream fitting.
   b. Install valve in vertical flow (up) piping only for gas services.
   c. Install swing check valve with shaft in horizontal position.
   d. Install double disc swing check valve to be perpendicular to flow pattern when discs are open.

6. Solenoid Valves: Install in accordance with manufacturer’s instructions.

E. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

F. Install safety isolation valves on compressed air.
G. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

H. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

I. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

J. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

K. Chain Wheel and Guide: Install chain wheel and guide assemblies or chain lever assemblies on manually operated valves over 6 feet 9 inches above finish floor. Install chain to within 3 feet of finish floor. Where chains hang in normally traveled areas, use appropriate “L” type tie-back anchors. Install chains to within operator horizontal reach of 2 feet 6 inches maximum, measured from normal operator standing location or station.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer’s data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.
3.03 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is part of this Specification.

1. Self-Contained Valve Schedule.

END OF SECTION
## SELF-CONTAINED VALVE SCHEDULE

<table>
<thead>
<tr>
<th>Tag No.</th>
<th>P&amp;ID Drawing No.</th>
<th>Valve Type</th>
<th>Size (inches)</th>
<th>Inlet* Pressure (psig)</th>
<th>Outlet Pressure (psig)</th>
<th>Flow (gpm)</th>
<th>Fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>I10PCV0020</td>
<td>08-N-001</td>
<td>V710</td>
<td>0,5</td>
<td>100</td>
<td>10</td>
<td>2</td>
<td>Water</td>
</tr>
<tr>
<td>I10ARV0001</td>
<td>08-N-001</td>
<td>V742</td>
<td>1</td>
<td>110</td>
<td>0</td>
<td>900 (main pipe flow)</td>
<td>Water</td>
</tr>
<tr>
<td>I10ARV0002</td>
<td>08-N-001</td>
<td>V742</td>
<td>1</td>
<td>110</td>
<td>0</td>
<td>900 (main pipe flow)</td>
<td>Water</td>
</tr>
<tr>
<td>I10ARV0003</td>
<td>08-N-001</td>
<td>V744</td>
<td>0.5</td>
<td>110</td>
<td>0</td>
<td>900 (main pipe flow)</td>
<td>Water</td>
</tr>
<tr>
<td>P20PCV0010</td>
<td>08-N-010</td>
<td>V710</td>
<td>0,5</td>
<td>60</td>
<td>10</td>
<td>2</td>
<td>Water</td>
</tr>
<tr>
<td>P20ARV0030</td>
<td>08-N-010</td>
<td>V744</td>
<td>0.75</td>
<td>75</td>
<td>0</td>
<td>1000 (main pipe flow)</td>
<td>Water</td>
</tr>
<tr>
<td>P30PCV0030</td>
<td>08-N-011</td>
<td>V710</td>
<td>0,5</td>
<td>30</td>
<td>10</td>
<td>2</td>
<td>Water</td>
</tr>
<tr>
<td>D56PCV0001</td>
<td>08-N-029</td>
<td>V714</td>
<td>8</td>
<td>60</td>
<td>42</td>
<td>900</td>
<td>Water</td>
</tr>
</tbody>
</table>

*Inlet Pressure = Set pressure for pressure relief valve or downstream set pressure for pressure reducing valve.
PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

2.  ASTM International (ASTM):
   h.  C585, Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.


4.  UL.
1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s descriptive literature.

B. Informational Submittals: Maintenance information.

PART 2 PRODUCTS

2.01 PIPE AND FITTING INSULATION

A. Type 1—Elastomeric:

1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534/C534M.
2. Temperature Rating: Minus 297 degrees F to 220 degrees F.
3. Nominal Density: 3 pcf to 6 pcf.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in./hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Maximum water vapor transmission of 0.06 perm-inch per ASTM E96/E96M, Procedure A.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
   a. Nomaco; K-Flex.
   b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
2. Insulation Temperature Rating: Zero to 850 degrees F.
3. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in./hr-square foot degrees F at 75 degrees F.
4. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96/E96M. Furnish with no jacket if field finish system specified.
5. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
7. Smoke Developed Index: Less than 50 per ASTM E84.
8. Manufacturers and Products:
   a. Owens Corning Fiberglass; ASJ/SSL-11.
   b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foamglass:

1. Material: Cellular glass per ASTM C552.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 degrees F to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in./hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96/E96M.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.
10. Follow manufacturer’s recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas One.

2.02 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

A. Type 1: 1 inch thick.

2.03 INSULATION AT PIPE HANGERS AND SUPPORTS

A. Refer to Section 40 05 15, Piping Support Systems.

B. Copper, Ductile Iron, and Nonmetallic Pipe: High-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield. Extend insert beyond shield.

C. Steel Pipe: Insulation saddle or high-density insert, thickness equal to adjoining insulation of Type 3 or other rigid insulation or manufactured pre-insulated pipe hanger and insulation shield at support location. Extend insert beyond shield.
2.04 INSULATION FINISH SYSTEMS

A. Type F1—PVC:
   1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, for straight run piping and fitting locations, temperatures to 140 degrees F.
   2. Color: PVC jacketing shall be color coded to match colors listed in pipe schedule where suitable matching colors are available. If no suitable colors are available jacketing shall be white.
   4. Smoke Developed Index: 50 per ASTM E84.
   5. Manufacturers and Products:
      a. Knauf Insulation; Proto 1000.
      b. Johns Manville; Zeston 2000 or 300.
      c. Speedline; 25/50 Smoke-Safe.

B. Type F2—Paint:
   1. Type 1 Insulation: Acrylic latex paint, white, and suitable for outdoor use.
   2. Type 2 Insulation: In accordance with Section 09 90 00, Painting and Coating.

C. Type F3—Aluminum:
   1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, in accordance with ASTM C1729, minimum 0.016-inch thickness, with smooth mill finish.
   2. Vapor Barrier: Provide factory applied vapor barrier, heat and pressure bonded to inner surface of aluminum jacketing.
   3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
   4. Manufacturers and Products:
      a. RPR Products; Insul-Mate.
      b. ITW; Pabco-Childers.

D. Type F4—Foamglass Jacketing:
   1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, self-sealing manual pressure seals; Pittsburgh Corning Pittwrap SS.
2. Type 3 Insulation—Greater than 1 Foot Above Grade: 30-mil modified bituminous membrane with self-sealing manual pressure seals; Pittsburgh Corning Pittwrap CW30.

PART 3 EXECUTION

3.01 APPLICATION

A. General:

1. Insulate valve bodies, flanges, and pipe couplings.
2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
3. Do not insulate flexible pipe couplings and expansion joints.
4. Service and Insulation Thickness: Refer to Supplement Service and Insulation Thickness Table following “End of Section” and to Piping Schedule as shown on Drawings.

3.02 INSTALLATION

A. General:

1. Install in accordance with manufacturer’s instructions and as specified herein.
2. Install after piping system has been pressure tested and leaks corrected.
3. Install over clean dry surfaces.
4. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
5. Do not allow insulation to cover nameplates or code inspection stamps.
6. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
7. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.

B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.

C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.
D. Placement:
   1. Insulate valves and fittings with sleeved or cut pieces of same material.
   2. Seal and tape joints.

E. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.

F. Roof Drains: Insulate vertical drops from roof drains to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.

G. Roof Drains and Overflow Drains: Insulate entire pipe runs. Where roof and overflow drains exist through an exterior wall ensure annular space between pipes and walls are properly sealed prior to insulating.

H. Roof Drain and Overflow Drain Sumps: Insulate entire sumps.

I. Vapor Barrier:
   1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
   2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
   3. Do not use staples and screws to secure vapor sealed system components.

J. Aluminum Jacket:
   1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
   2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
   3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
   4. Do not use screws or rivets to fasten fitting covers.
   5. Install removable prefabricated aluminum covers on exterior flanges and unions.
   6. Caulk and seal exterior joints to make watertight.
3.03 FIELD FINISHING

A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.

B. Where pipe labels or banding are specified, apply to finished insulation, not to pipe.

C. Painting Piping Insulation (Exposed to View):
   1. Aluminum or color coded PVC jacketing does not require painting.
   2. If insulated piping system is indicated to be painted in Section 40 27 00, Process Piping—General, piping shall receive the following:
      a. Prime coat in accordance with Section 09 90 00, Painting and Coating.
      b. Finished insulation (and not pipe) shall be painted in accordance with Section 09 90 00, Painting and Coating.

3.04 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:
   1. Service and Insulation Thickness Table.

END OF SECTION
### SERVICE AND INSULATION THICKNESS

<table>
<thead>
<tr>
<th>Service Type</th>
<th>Pipe Legend</th>
<th>Thickness</th>
<th>Fluid Temperature (degrees F)*</th>
<th>Insulation</th>
<th>Finish Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>DW–Domestic and Service Hot Water Systems.</td>
<td>HW, TW</td>
<td>ASHRAE 90.1 or IECC whichever results in thickest insulation.</td>
<td>105 to 140</td>
<td>Type 1 (6” or less)</td>
<td>None</td>
</tr>
<tr>
<td>CS–Cooling Systems (Condensate control, chilled water, and refrigerant)</td>
<td>RD W1, W2, SW</td>
<td>ASHRAE 90.1 or IECC whichever results in the thickest insulation.</td>
<td>40 to 60</td>
<td>Type 1 (6” or less)</td>
<td>None</td>
</tr>
</tbody>
</table>

*Use these fluid temperatures unless otherwise noted in the Piping Schedule.

Inches*: Based upon insulation with glass fiber per ASTM C547, outdoors with 20 mph wind with 10 percent safety and no value assigned to cladding or air space at cladding. 2012 IECC requires 1-inch minimum thickness.
PART 1    GENERAL

1.01    SUBMITTALS

A.    Informational Submittals:

   1.    Testing Plan:
   a.    Submit prior to testing and include at least the information that
         follows.
   1)    Testing dates.
   2)    Piping systems and section(s) to be tested.
   3)    Test type.
   4)    Method of isolation.
   5)    Calculation of maximum allowable leakage for piping
         section(s) to be tested.


PART 2    PRODUCTS (NOT USED)

PART 3    EXECUTION

3.01    PREPARATION

A.    Notify Engineer in writing 5 days in advance of testing. Perform testing in
      presence of Engineer.

B.    Pressure Piping:

   1.    Install temporary thrust blocking or other restraint as necessary to
         protect adjacent piping or equipment and make taps in piping prior to
         testing.
   2.    Wait 5 days minimum after concrete thrust blocking is installed to
         perform pressure tests. If high-early strength cement is used for thrust
         blocking, wait may be reduced to 2 days.
   3.    Prior to test, remove or suitably isolate appurtenant instruments or
         devices that could be damaged by pressure testing.
   4.    New Piping Connected to Existing Piping:
   a.    Isolate new piping with grooved-end pipe caps, spectacle blinds,
         blind flanges, or as acceptable to Engineer.
PHASE IV BEAVER CREEK WATER SUPPLY

b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.

5. Items that do not require testing include piping between wetwells and wetwell isolation valves, equipment seal drains, tank overflows to atmospheric vented drains, and tank atmospheric vents.

6. Test Pressure: As indicated on Piping Schedule as shown on Drawings.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Test pressure shown on Piping Schedule as shown on Drawings is the pressure at the lowest elevation point in the system. Monitor test pressure at appropriate point in system.

C. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 60 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

D. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
6. Maximum Allowable Leakage:

\[
L = \frac{SDP^{1/2}}{148,000}
\]

where:

- \( L \) = Allowable leakage, in gallons per hour.
- \( S \) = Length of pipe tested, in feet.
- \( D \) = Nominal diameter of pipe, in inches.
- \( P \) = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Pneumatic testing is only allowed when specified on the Piping Schedule as shown on Drawings or by approval of the Engineer.

B. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 18 inches.
3. Buried and other nonexposed piping.

C. Fluid: Oil-free, dry air.

D. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.

5. Correct visible leakage and retest as specified.

E. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

F. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

D. Exfiltration Test:
   1. Hydrostatic Head:
      a. At least 6 feet above maximum estimated groundwater level in section being tested.
      b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.

   2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

E. Infiltration Test:

   1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

   F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

   G. Defective Piping Sections: Replace and retest as specified.
3.05 PNEUMATIC TEST FOR GRAVITY PIPING

A. Equipment:

1. Calibrate gauges with standardized test gauge provided by Inspector at start of each testing day. Inspector will witness calibration.
2. Install gauges, air piping manifolds, and valves at ground surface.
3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 psi to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed using values from following table:

<table>
<thead>
<tr>
<th>Pipe Diameter (Inches)</th>
<th>Time per Foot up to Length in Col C (Seconds)</th>
<th>Test Length (Feet)</th>
<th>Test Time for any Length Between Col C &amp; E (Min:Sec)</th>
<th>Length at Which Time in Col F Applies (Feet)</th>
<th>Time per Foot for Total Length (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.18</td>
<td>636</td>
<td>1:54</td>
<td>1,114</td>
<td>0.10</td>
</tr>
<tr>
<td>6</td>
<td>0.40</td>
<td>424</td>
<td>2:50</td>
<td>743</td>
<td>0.23</td>
</tr>
<tr>
<td>8</td>
<td>0.71</td>
<td>318</td>
<td>3:47</td>
<td>557</td>
<td>0.41</td>
</tr>
<tr>
<td>10</td>
<td>1.11</td>
<td>255</td>
<td>4:43</td>
<td>446</td>
<td>0.63</td>
</tr>
<tr>
<td>12</td>
<td>1.60</td>
<td>212</td>
<td>5:40</td>
<td>371</td>
<td>0.91</td>
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<tr>
<td>15</td>
<td>2.50</td>
<td>170</td>
<td>7:05</td>
<td>297</td>
<td>1.42</td>
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<tr>
<td>18</td>
<td>3.62</td>
<td>141</td>
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<td>248</td>
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<tr>
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<td>212</td>
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<tr>
<td>24</td>
<td>6.42</td>
<td>106</td>
<td>11:20</td>
<td>187</td>
<td>3.67</td>
</tr>
</tbody>
</table>

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Table 1*

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe Diameter (Inches)</td>
<td>Time per Foot up to Length in Col C (Seconds)</td>
<td>Test Length (Feet)</td>
<td>Test Time for any Length Between Col C &amp; E (Min:Sec)</td>
<td>Length at Which Time in Col F Applies (Feet)</td>
<td>Time per Foot for Total Length (Seconds)</td>
</tr>
</tbody>
</table>

Example: 15-inch diameter pipe:
For 150 feet, T = 2.50 sec (Col B) x 150 ft = 375 sec = 6:15
For 250 feet, T = 7:05 (Col D)
For 500 feet, T = 1.42 sec (Col F) x 500 ft = 710 sec = 11:50

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace and retest as specified.

3.06 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Inspector to represent that test has been satisfactorily completed.

END OF SECTION
SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Section 40 91 00, Instrumentation and Control Components.
2. Section 40 95 80, Network Communication Systems.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, control panels, and field panels.
2. Programmable controllers.
3. Purchase and deliver Computer Subsystem hardware and software as defined under Article Allowances to Software Integrator for configuration and software installation. Software Integrator to deliver configured hardware to site for hardware installation by Contractor.
4. Drawings, including but not limited to, loop wiring diagrams, network diagrams, detailed panel drawings, and others specified hereinafter.
5. Network installation and testing including:
   a. Fiber optic communications network between the intake building and the membrane building including fiber cables, patch panels, and network switches.
   b. Internet communications via DSL phone link between the membrane building, SRWD main office, 98th Street PRV, and 123rd Street PRV.
   c. Remote alarm notification phoneline and modem.
6. Installation of Owner provided pre-purchased membrane instruments and coordination with membrane supplier for confirmation of proper installation as shown on Drawings.
7. Applications Software:
   a. Provided by Engineer for the following:
      1) Intake PLC I10PLC0001.
      2) Plant PLC P20PLC0001.
      3) 98th Street PRV PLC D55PLC0001.
4) 123rd Street PRV PLC software modifications for Lost Creek Booster Pump Station.
5) Plantwide HMI.
6) Alarm dialer configuration.
7) Control system workstation and server operating system configuration including virtualization configuration.
   a) P20SVR9801 Server Virtualization:
      (1) VM1: Primary HMI server.
      (2) VM2: Historian/Factory Talk Directory.
      (3) VM3: Operator Workstation 1.
      (4) VM4: Spare virtual machine.
   b) P20SVR9802 server virtualization:
      (1) VM1: Standby HMI server.
      (2) VM2: Engineering Workstation & Alarm Dialer.
      (3) VM3: Operator Workstation 2.
      (4) VM4: Spare virtual machine.
   c) P20WKST9601 Workstation.
   d) P20WKST9602 Workstation.
   e) I10WKST9601 Workstation.
   f) Main Office Plant Workstation.
   g) Laptop.
8) Firewall and network switch configuration.
9) Contractor work related to supporting this activity includes:
   a) Early delivery of programming equipment to Engineer’s office.
   b) Assistance with onsite Functional Test 2 and checkout of applications software.
   b. Provided by Westech, the prepurchased membrane system supplier:
      1) Panel P21CP0001 including:
         a) Membrane PLC P21PLC0001.
         b) Membrane OIT.
   c. Provided by Sodium Hypochlorite Package System Vendor:
      1) Panel P20CP0003 including:
         a) Sodium Hypochlorite PLC P20PLC0003.
         b) Sodium Hypochlorite OIT.
8. Connection of POE Ethernet camera to firewall at Membrane Building.
9. Y4Complete and thorough testing of all control loop circuits including interlocks between all equipment and testing of I/O wiring to the control panels. I/O to the panels includes PIC system instruments, existing panels, package system panel interfaces, interface to devices supplied by others, including but not limited to, motor control centers, drives, valves, instruments and other similar devices.
10. Construction, installation, and testing of all control panels, field panels, and server racks as shown on Drawings and schedules.

11. Installation of Westech supplied analytical instruments as part of field panel P20FP0010 construction. Instruments to be installed prior to completion of factory demonstration test.

12. Installation of all Westech supplied panels including P21CP0001, P21CP0002, P21CP0003, and P21CP0004.

13. Installation of instruments supplied as part of sodium hypochlorite generation system. Calibration and testing to be completed by supplier.
   a. LEL transmitter P20AIT0111.
   b. Sodium hypochlorite tank level P20LE0117/P20LIT0117.
   c. Sodium hypochlorite tank ventilation flow switch P20FE/FSL0117.
   d. Brine Tank level transmitters P20LIT0113A and P20LIT0113B.

14. Owner control standards include the following, and are required for this project:
   a. HMI Software: Rockwell FactoryTalk ViewSE.
   b. PLCs: Allen Bradley ControlLogix or CompactLogix.
   c. PLC Programming Software: Rockwell Studio 5000.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section and other PIC subsections:

2. ASTM International (ASTM):
3. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
DEFINITIONS

A. Abbreviations:

1. DSL: Digital Subscriber Line.
2. FDT: Factory Demonstration Test.
3. FT: Functional Test.
5. HMI: Human-Machine Interface.
6. HVAC: Heating, Ventilating, and Air Conditioning.
7. I&C: Instrumentation and Control.
8. I/O: Input and Output.
11. PC: Personal Computer.
13. PCS: Plant Control System.
14. PLC: Programmable Logic Controller.
15. POE: Power over Ethernet.
16. PT: Performance Test.
17. RTU: Remote Terminal Unit.
18. SCADA: Supervisory Control and Data Acquisition.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.

2. SCADA Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing configuring and run-time capability for, data acquisition (I/O driver, OPC servers, etc.), monitoring, alarming, human-machine interface, supervisory control, data collection, data retrieval, trending, report generation, control, and diagnostics.

3. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.

E. Application Software: Software to provide functions unique to this Project and that are not provided by standard software alone, including but not limited to:

1. Configuring databases, tables, displays, historians, reports, parameter lists, ladder logic, function block, and control strategies required to implement functions unique to this Project.

2. Programming in any programming or scripting language.

F. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.

2. Falling: Contacts close when a decreasing process variable falls through setpoint.
G. Signal Types:

1. Analog Signal, Current Type:
   a. 4 mA to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.
2. Analog Signal, Voltage Type: 1V dc to 5V dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
   a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
   b. Pulses generated by contact closures or solid state switches.
   c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Detailed Wiring Design: Panel wiring diagrams, interconnecting wiring diagrams, and loop wiring diagrams are included on Drawings and designed to completely show control panel wiring, terminations, wire numbers, interfaces with other systems, hardwired functions, interlocks, and wiring of components to be provided.

B. Design Requirements:

1. Complete detailed design of PIC components and PIC Drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
   a. Functional requirements, performance requirements, and component specifications.
   b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.
C. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
   a. Completing detail design.
   b. Submittals.
   c. Equipment, enclosures, and ancillaries.
   d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
   e. Verify readiness for operation.
   f. Verify correctness of final power and signal connections (lugging and connecting).
   g. Adjusting and calibrating.
   h. Starting up.
   i. Testing and coordination of testing.
   j. Training.
   k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.

2. Verify following Work not by PIC System Integrator is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.

3. Non-PIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers’ information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer’s recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, but not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Chemical feed pump and feeder speed/stroke controls.
      3) Automatic samplers.
      4) Motor control centers.
      5) Adjustable speed and adjustable frequency drive systems.
   f. Examples of items not in this category:
      1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

4. PIC integrator main office shall be within 150 miles of plant site and have the capability to provide 24/7 on call support once the facility is operational. Response time for providing onsite support shall be within 4 hours once call is received.

1.05 ALLOWANCES

A. Allowances under this Work are contingency allowances. They may or may not be utilized. They shall be done only when and as directed in writing by the Owner.

B. The amount given in the Bid Form under each Allowance Item is the sum of money set aside for each allowance. These amounts shall be included in the Contract Price on the Bid Form.

C. If the cost of Work done under any allowance is less than the amount given on the Bid Form under the Allowance Item, the contract sum shall be reduced the difference between the amount given in the Bid Form and the cost of Work actually done. This reduction in contract sum shall be done under the final modification of Contract.

D. Scope of Allowances:

   a. Computer subsystem equipment to be selected by the Owner’s Software Integrator at a later date.
   b. Hardware:
      1) Plant operator workstations P20WKST9601, P20WKST9602.
      2) Intake Building panel mounted workstation I10WKST9601.
      3) Plant workstation located at main office.
      4) Plant Servers P20SVR9801, P20SVR9802.
      5) Network firewall P20FW9501.
      6) Network firewall D55FW0001.
      7) Laptop.
      8) Printer.
      9) External USB hard drives for data backup/transfer.
     10) POE injector.
   c. Software:
      1) Rockwell Software Studio5000 PLC programming software.
      2) Rockwell Software FactoryTalk View HMI runtime software.
3) Rockwell Software FactoryTalk View HMI development software.
4) Rockwell Software FactoryTalk Historian software.
5) Specter Instruments Win911 Remote Alarm notification software including USB modem.
6) Operator Workstations and Laptop:
   a) Windows Operating System.
   b) Windows MSOffice Pro.
   c) Anti-virus.
7) Servers:
   a) Virtualization software.
   b) Windows Server operating system.
   c) Anti-virus.

1.06 SUBMITTALS

A. General:

1. Submit proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Partial Submittals not in accordance with Project Schedule will not be accepted.
3. Submittal Format:
   a. Hard Copy: Required for all submittals.
   b. Electronic Copies: Required, unless otherwise noted for specific items.
      1) Manufacturers’ Standard Documents: Adobe Acrobat PDF.
      2) Documents created specifically for Project:
         a) Text and Graphics: Microsoft Word.
         b) Lists: Microsoft Excel, unless otherwise noted for specific items.
         c) Drawings: AutoCAD.
4. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
5. Legends and Abbreviation Lists:
   a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
   b. Use identical abbreviations in PIC subsections.
   c. Submit updated versions as they occur.
6. Activity Completion:
   a. Action Submittals: Completed when reviewed and approved.
   b. Informational Submittals: Completed when reviewed and found to meet conditions of the Contract.

B. Action Submittals:

   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
      6) For panels, include panel reference number and name plate inscription.
   c. Formats: Hard copy and Microsoft Excel.

2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.

3. Instrument List:
   a. Engineer will provide an initial Instrument List in Microsoft Excel. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.
   b. Applicable fields to be completed include, but are not limited to:

<table>
<thead>
<tr>
<th>Instrument List Characteristics</th>
<th>Initially Completed By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Engineer</td>
</tr>
<tr>
<td>Tag Number</td>
<td>Engineer</td>
</tr>
<tr>
<td>Loop Number</td>
<td>Engineer</td>
</tr>
<tr>
<td>Description</td>
<td>Engineer</td>
</tr>
</tbody>
</table>
Instrument List Characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Initially Completed By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer and complete model number</td>
<td>Contractor</td>
</tr>
<tr>
<td>Size and scale range</td>
<td>Engineer</td>
</tr>
<tr>
<td>Setpoints</td>
<td>Engineer</td>
</tr>
<tr>
<td>Reference P&amp;IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings</td>
<td>Engineer</td>
</tr>
<tr>
<td>Instrument detail number</td>
<td>Engineer</td>
</tr>
</tbody>
</table>

c. Submit updated version of Instrument List.
d. Electronic Copies: Microsoft Excel.

4. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content:
      1) Specific features and configuration data for each component, including but not limited to:
         a) Tag Number.
         b) Component type identification code and description.
         c) Location or service.
         d) Service conditions.
         e) Manufacturer and complete model number.
         f) Size and scale range.
         g) Setpoints.
         h) Materials of construction.
         i) Options included.
         j) Power requirements.
         k) Signal interfaces.
         l) Name, address, and telephone number of manufacturer’s local office, representative, distributor, or service facility.
   c. Electronic Copies: Microsoft Excel.
5. Sizing and Selection Calculations:
   a. Primary Elements:
      1) Complete calculations plus process data used. Example for Flow Elements:
         a) Minimum and maximum values, permanent head loss, and assumptions made.
   b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
   c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.

6. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and location of front of panel devices.
   b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Submit electronic copies of Drawings.

7. Panel Construction Drawings:
   a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
   b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
   c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
   d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
   e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
   f. Submit electronic copies of Drawings.

8. Detailed Wiring Diagrams:
   a. Refer to Drawings for Detailed Wiring Diagrams including:
      1) Panel Wiring Diagrams for discrete control and power circuits.
      2) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
      3) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.
b. Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.

c. Submit electronic copies of Drawings.

9. Panel Wiring Diagrams:

a. Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.

b. Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.

c. Diagram Type:

1) Ladder diagrams where applicable in a format similar to those shown on Drawings. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.

2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

d. Item Identification: Identify each item with attributes listed.

1) Wires: Wire number and color. Cable number if part of multiconductor cable.

2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.

3) Components:

a) Tag number, terminal numbers, and location (“FIELD”, enclosure number, or MCC number).

b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).

4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.

5) Relay Coils:

a) Tag number and its function.

b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.

6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).

7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.

e. Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.
f. Ground wires, surge protectors, and connections.
g. Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits entering and leaving a panel. Refer to Division 26, Electrical.

10. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
   a. Conform to the minimum requirements of ISA S5.4.
   b. Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
   c. Show loop components within a panel and identify each component, component terminals, and panel terminals.
   d. If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
      1) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
      2) Identify the component by tag and description.
      3) Identify panel and component terminal numbers.
   e. Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
   f. Divide each loop diagram into areas for panel face, back-of-panel, field and PLC.
   g. One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
   h. Show:
      1) Terminal numbers, location of dc power supply, and location of common dropping resistors.
      2) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
      3) Tabular summary on each analog loop diagram:
         a) Transmitting Instruments: Output capability.
         b) Receiving Instruments: Input impedance.
         c) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
         d) Total loop impedance.
         e) Reserve output capacity.
      4) Circuit and raceway schedule names.

11. Communications and Digital Networks Diagrams: As per Section 40 95 80, Network Communication Systems.

12. Panel Power Requirements and Heat Dissipation: For control panels tabulate and summarize:
   a. Required voltages, currents, and phases(s).
b. Maximum heat dissipations Btu per hour.

c. Calculations.

d. Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 100 degrees F.

13. Panel Plumbing Diagrams: For each panel containing piping and tubing. 
Show type and size for:

a. Pipes and Tubes: Thickness, pressure rating, and materials.

b. Components: Valves, regulators, and filters.

c. Connections to panel-mounted devices.

d. Panel interface connections.

e. Submit electronic copies of Drawings.

14. Installation Details: Include modifications or further details required and define installation of I&C components.

15. Spares, expendables, and test equipment.


17. PLC I/O List:

a. Managed by Engineer:

1) During construction Engineer will maintain PLC I/O List and give electronic Microsoft Excel copies to PIC System Integrator.

2) Engineer will assign PLC I/O points to specific chassis, slot, and point addresses.

b. PLC I/O List Changes: Changes to PLC I/O List reflecting actual equipment and instrumentation provided.

1) Mark up electronic file of latest PLC I/O List from Engineer. Highlight changed cells with yellow, new rows with red, and rows to be deleted with green.

2) Submit marked up copies changes at 30-day intervals.

18. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.

19. Shop Drawings for Changes Impacting PLC and SLDC Programming:

a. Submit details of changes required to PLC and SLDC monitoring and control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.

b. Submit changes at 30-day intervals.

20. Submit anchorage and bracing design drawings, cut sheets, and their installation information for components, distribution systems, and equipment as required by Section 01 88 15, Anchorage and Bracing. Drawings shall be stamped by an Engineer licensed in the State of Oregon.
C. Informational Submittals:

1. Statements of Qualification:
   a. PIC System Integrator.
   b. PIC System Integrator’s site representative.
   c. Resume for each PIC System Integrator’s onsite startup and testing team member (engineers, technicians, and software/configuring personnel).

2. Operation and Maintenance Data: In accordance with Section 01 78 23, Operation and Maintenance Data, and in addition the following:
   a. General:
      1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
      2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
   b. Final versions of Legend and Abbreviation Lists.
   c. Process and Instrumentation Diagrams: Marked up copy of revised P&ID to reflect as-built PIC design.
   d. Provide the following items as defined under heading Action Submittals:
      1) Bill of materials.
      2) Catalog cuts.
      3) Instrument list.
      4) Component data sheets.
         a) Panel wiring diagrams.
         b) Loop diagrams.
         c) Interconnecting wiring diagrams.
      6) Panel plumbing diagrams.
      7) Communication and Digital Network Diagrams: As required by Section 40 95 80, Network Communication Systems.
   e. Manufacturer’s O&M manuals for components, electrical devices, and mechanical devices:
      1) Content for Each O&M Manual:
         a) Table of Contents.
         b) Operations procedures.
         c) Installation requirements and procedures.
         d) Maintenance requirements and procedures.
         e) Troubleshooting procedures.
         f) Calibration procedures.
         g) Internal schematic and wiring diagrams.
h) Component and I/O Module Calibration Sheets from field quality control calibrations.

2) Provide PDF file with linked index to all manuals.

f) List of spares, expendables, test equipment and tools provided.

g) List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

3. Provide Manufacturer’s Certificate of Proper Installation where specified.

4. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.
         b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
      3) Test Documentation: Copy of signed-off test results.
   b. Functional Test Part 1 and Part 2:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation:
         a) Copy of signed-off test results.
         b) Completed component calibration sheets.
   c. Performance Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results.

5. Owner Training Plan: In accordance with Section 01 43 33, Manufacturers’ Field Services.

6. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Owner and maintenance provider for work required under Article Maintenance Service.
1.07 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 5 years’ experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator’s Site Representative: Minimum of 5 years’ experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. General: Refer to Section 01 31 19, Project Meetings, for PIC coordination meetings.
2. PIC Schedule Coordination Meeting:
   b. Purpose: Discuss Engineer’s comments and resolve scheduling issues.
3. Training Coordination Meeting:
   b. Purpose:
      1) Resolve required changes to proposed training plan.
      2) Identify specific Owner personnel to attend training.

1.08 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements.

B. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

C. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

D. Cover panels and other elements that are exposed to dusty construction environments.

1.09 SEQUENCING AND SCHEDULING

A. Refer to Section 01 31 13, Project Coordination, for Contractor’s scheduling requirements for applications software testing.
B. Prerequisite Activities and Lead Times:

1. Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
   a. Shop Drawing Reviews by Engineer:
      1) Prerequisite: Engineer acceptance of Schedule of Values and Progress Schedule.
      2) Schedule: In accordance with completed schedule of Shop Drawing and Sample submittals specified in Section 01 33 00, Submittal Procedures.
   b. Test Prerequisite: Associated test procedures Submittals completed.
   c. Training Prerequisite: Associated training plan Submittal completed.
   d. PLC and HMI Configuring Equipment Delivered to Engineer’s office:
      1) Refer to PIC subsections for a definition of this equipment.
   e. PLC and HMI Shipment to Site:
      1) General Prerequisites:
         a) Approval of PIC Shop Drawings and preliminary operation and maintenance data.
         b) FDT completed.
   f. Functional Test Part 1 Prerequisite:
      1) PLC and HMI installation complete.
      2) Communication System Functional Tests complete, as specified in Section 40 95 80, Network Communication Systems.
   g. Functional Test Part 2 Prerequisite: Functional Test Part 1 completed.
   h. Performance Test Prerequisite: Functional Test Part 2 completed and facility started up.

C. Allowance for Interruptions to Contractor’s Work Due to Application Software Testing:

1. During Functional Test 2 and Performance Testing, Contractor shall anticipate interruption of testing and delays to Work and allow:
   a. Investigation of software problems by Software Integrator.
   b. Software configuration changes made.
   c. Retesting.

2. Duration:
   a. 10 working days total for FT2.
   b. 7 working days total for PT.
1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

<table>
<thead>
<tr>
<th>Description</th>
<th>Percent of Each Type and Size Used</th>
<th>No Less Than</th>
</tr>
</thead>
<tbody>
<tr>
<td>dc power supplies</td>
<td>20</td>
<td>2</td>
</tr>
<tr>
<td>Fuses</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Indicating light bulb</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Relays</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td>Terminal Blocks</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Hand Switches and Lights</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>Surge Suppressors</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

D. Expendables: For following items provide manufacturer’s recommended 2-year supply, unless otherwise noted.

1. Chemical for analyzers.
2. Calibration/test gas for combustible gas detection.
4. pH Sensor Overhaul Kits: Two.
5. Spray pump filter adhesive; Hoffman Model A-FLTAD. One pint per panel with air filters.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software (except for Engineer provided applications software), whether indicated or not, necessary to effect required system and loop performance.
B. First Named Manufacturer: PIC design is based on first named manufacturers of equipment, materials, and software.

1. If an item is proposed from other than first named manufacturer, obtain approval from Engineer for such changes in accordance with the General Conditions, Article 7.04, “Or Equals”, and Article 7.05, Submittals.
2. If proposed item requires, but not limited to, different installation, wiring, raceway, enclosures, intrinsically safe barriers, and accessories, provide such equipment and work.

C. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer’s services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC Equipment List in Article Supplements, and PLC components in Section 40 91 00, Instrumentation and Control Components.
2.04 FIELD BUS, NETWORK, AND HMI COMPONENTS

A. Reference PIC subsections.

2.05 SERVICE CONDITIONS

A. Standard Service Conditions:

1. The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:

   a. Computer Room, Air Conditioned:
      1) Temperature: 60 degrees F to 80 degrees F.
      2) Relative Humidity: 40 percent to 60 percent.
      3) NEC Classification: Nonhazardous.
      4) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 104 degrees F.

   b. Inside, Air Conditioned:
      1) Temperature:
         a) Normal: 60 degrees F to 80 degrees F.
         b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 104 degrees F.
      2) Relative Humidity:
         a) Normal: 10 percent (winter) to 70 percent (summer).
         b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.

   c. Inside:
      1) Temperature: 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.

   d. Inside, Corrosive:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 95 percent noncondensing.
      3) Corrosive Environment: Sea air.
      4) NEC Classification: Nonhazardous.

   e. Inside, Hazardous:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 95 percent noncondensing.
      3) NEC Classification: As shown on Electrical Drawings.

   f. Outside, Corrosive:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 0 percent to 100 percent, rain, snow, freezing rain.
3) Corrosive Environment: Sea air.
4) NEC Classification: Nonhazardous.

Outside, Hazardous:
1) Temperature: Minus 20 degrees F to 104 degrees F.
2) Relative Humidity: 0 percent to 100 percent, rain, snow, freezing rain.
3) NEC Classification: As shown on Electrical Drawings.

B. Standard Service Conditions for Panels and Consoles:

1. Unless otherwise noted, in Control Panel Schedule located in Article Supplements at End of Section, design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside, Air Conditioned: NEMA 1.
      2) Inside: NEMA 12.
   b. Smaller Panels and Assemblies (that are not freestanding):
      1) Inside, Air Conditioned: NEMA 12.
      2) All Other Locations: NEMA 4X.
   c. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: Refer to Example Control Panel Layouts and Control Panel Schedule Drawings.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch-high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.
C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.
   1. Inscription: Component tag number.
   3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.
   1. Inscription:
      a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
      b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
      c. Refer to P&IDs on Drawings.
   2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
   3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.
   1. Inscription: As shown on panel drawing.
   3. Letters: 3/16-inch-high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.
   1. Inscription: Component tag number.
   4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on Drawings.
B. Supplemented by Loop Specifications provided by Software Integrator that describe requirements not obvious on P&IDs or panel control diagrams.

C. Supplemented by standard functional requirements in PIC subsections.

2.09 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

B. Wiring External to PIC Equipment:
   1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
   2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. Wires within Enclosures:
   1. ac Circuits:
      a. Type: 600-volt, Type MTW stranded copper.
      b. Size: For current to be carried, but not less than No. 18 AWG.
   2. Analog Signal Circuits:
      a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
      b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Belden No. 1121A.
      c. Size: No. 18 AWG, minimum.
   3. Other dc Circuits.
      a. Type: 600-volt, Type MTW stranded copper.
      b. Size: For current carried, but not less than No. 18 AWG.
   4. Special Signal Circuits: Use manufacturer’s standard cables.
   5. Wire Identification: Numbered and tagged at each termination.
      a. Wire Tags: Machine printed, heat shrink.
      b. Manufacturers:
         1) Brady Perma Sleev.
         2) Tyco Electronics.

E. Terminate and identify wires entering or leaving enclosures as follows:
   1. Analog and discrete signal, terminate at numbered terminal blocks.
   2. Special signals terminated using manufacturer’s standard connectors.
3. Identify wiring in accordance with requirements in Section 26.05.05, Conductors.

F. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on Drawings.

2. Terminal Block Types: Reference Section 40.91.00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.
3. Single Point Ground for Each Analog Loop:
   a. Locate signal ground at dc power supply for loop.
   b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

2. Install intrinsically safe circuits in a separate wire way that:
   a. Is separated from nonintrinsically safe circuits as specified by NEC.
   b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.
J. **Wiring Interface:** Terminate and identify wiring entering or leaving enclosures.

1. **Analog and Discrete Signal Wires:** Terminate at numbered terminal blocks as shown on the wiring diagrams.
2. **Wiring for Special Signals:** Terminate communications, digital data, and multiplexed signals using manufacturer’s standard connectors for the device to which the signals terminate.

### 2.10 PANEL FABRICATION

**A. General:**

1. **Nominal Panel Dimensions:** Refer to Control Panel Schedule in Article Supplements for maximum external dimensions allowed for individual control panels.
2. **Instrument Arrangements:** As shown on Drawings.
3. **Panel Component Schedule:** Refer to Control Panel Schedule in Article Supplements which provides a list by local control panel of major panel-mounted components for each panel. In case of a conflict between this list and Instrument List, Instrument List takes precedence. In case of a conflict between Panel Component Schedule and P&IDs, P&IDs take precedence.
4. **Panel Construction and Interior Wiring:** In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
5. **Fabricate panels, install instruments and wire, and plumb at PIC System Integrator’s facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.**
6. **UL Listing Mark for Enclosures:** Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.
7. **Electrical Work:** In accordance with the applicable requirements of Division 26, Electrical.

**B. Temperature Control:**

1. **Freestanding Panels:**
   a. **Nonventilated Panels:** Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. **Ventilated Panels:**
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
3) For panels without backs against wall, furnish louvers on top and bottom of panel back.

4) Louver Construction: Stamped sheet metal.

5) Ventilation Fans:
   a) Furnish where required to provide adequate cooling.
   b) Create positive internal pressure within panel.
   c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.

6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
   c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.

2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.

3. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
   b. Refer to Control Panel Schedule in Article Supplements.

C. Freestanding Panel Construction:

1. Materials:
   a. Sheet steel, unless otherwise noted in Control Panel Schedule in Article Supplements.
   b. Minimum Thickness: 10-gauge, unless otherwise noted.

2. Panel Front:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on Drawings.
   b. No seams or bolt heads visible when viewed from front.
   c. Panel Cutouts: Smoothly finished with rounded edges.
   d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.

3. Internal Framework:
   a. Structural steel for instrument support and panel bracing.
   b. Permit panel lifting without racking or distortion.

4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.

5. Adjacent Panels: Securely bolted together so front faces are parallel.

6. Door:
   a. Full height, fully gasketed access door where shown on Drawings.
   b. Latch: Three-point, Southco Type 44.
   c. Handle: “D” ring, foldable type.
d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
f. Front and Side Access Doors: As shown on Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements and referenced in Article Environmental Requirements, provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
   a. Panels listed as inside, air conditioned:
      1) Enclosure Type: NEMA 12.
      2) Materials: Steel.
   b. Other Panels:
      1) Enclosure Type: NEMA 4X.
      2) Materials: Type 316 stainless steel.


3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.

4. Manufacturers:
   b. H. F. Cox.

E. Breather and Drains:

1. Furnish with NEMA 250, Type 4 and Type 4X Panels:
   a. Manufacturer and Product: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

F. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.
2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
   a) Branch Circuit Breakers: 15 amps at 250V ac.
3) Breaker Manufacturers and Products: Square D; Type QO.
   c. Circuit Wiring:
      1) P&IDs and Control Diagrams on Drawings show function only. Use following rules for actual circuit wiring:
         a) Devices on Single Circuit: 20, maximum.
         b) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
         c) Branch Circuit Loading: 12 amperes continuous, maximum.
         d) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
         e) Provide 120V ac plugmold for panel components with line cords.

2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 mA to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 mA to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.
   e. RTD and Thermocouple Extension Cable:
      1) Continuous field to panel with no intermediate junction boxes or terminations.
      2) RTDs in motor windings are considered a 600-volt circuit.
      3) Terminate thermocouple extension wire directly to loop instrument.

3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 mA to 20 mA loops during switching.
   c. Switching Transients in Associated Signal Circuit:
      1) 4 mA to 20 mA dc Signals: 0.2 mA, maximum.
      2) 1V dc to 5V dc Signals: 0.05V, maximum.

4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.

6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched 100-watt incandescent back-of-panel lights.
   b. Quantity: One light for every 4 feet of panel width.
c. Mounting: Inside and in the top of back-of-panel area.

d. Protective metal shield for lights.

7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.

8. Internal Panel Lights and Service Outlets for Smaller Panels:
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI GFCI duplex receptacle:
   c. Required for panels. Refer to Control Panel Schedule in Article Supplements.

9. Standard Pushbutton Colors and Inscriptions:

<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>OO</td>
<td>ON OFF</td>
<td>Black Black</td>
</tr>
<tr>
<td>OC</td>
<td>OPEN CLOSE</td>
<td>Black Black</td>
</tr>
<tr>
<td>OCA</td>
<td>OPEN CLOSE AUTO</td>
<td>Black Black</td>
</tr>
<tr>
<td>OOA</td>
<td>ON OFF AUTO</td>
<td>Black Black</td>
</tr>
<tr>
<td>MA</td>
<td>MANUAL AUTO</td>
<td>Black Black</td>
</tr>
<tr>
<td>SS</td>
<td>START STOP</td>
<td>Black Black</td>
</tr>
<tr>
<td>RESET</td>
<td>RESET</td>
<td>Black</td>
</tr>
<tr>
<td>EMERGENCY STOP</td>
<td>EMERGENCY STOP</td>
<td>Red</td>
</tr>
</tbody>
</table>

a. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.
10. Standard Light Colors and Inscriptions:
   a. Use following color code and inscriptions for service legends and 
      lens colors for indicating lights.

<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>ON</td>
<td>Green</td>
</tr>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Red</td>
</tr>
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<td>OPEN</td>
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<tr>
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<td>Amber</td>
</tr>
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<td>HIGH</td>
<td>HIGH</td>
<td>Amber</td>
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<td>FORWARD</td>
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<tr>
<td>REVERSE</td>
<td>REVERSE</td>
<td>Red</td>
</tr>
<tr>
<td>REMOTE</td>
<td>REMOTE</td>
<td>Blue</td>
</tr>
</tbody>
</table>

b. Lettering Color:
   1) Black on white and amber lenses.
   2) White on red and green lenses.

G. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around 
   longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.
4. Provide abrasion protection for wire bundles that pass through holes or 
   across edges of sheet metal.
5. Connections to Screw Type Terminals:
   a. Locking-fork-tongue or ring-tongue lugs.
   b. Use manufacturer’s recommended tool with required sized anvil 
      to make crimp lug terminations.
   c. Wires terminated in a crimp lug, maximum of one.
   d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
   a. Strip, prepare, and install wires in accordance with terminal
      manufacturer’s recommendations.
   b. Wires installed in a compression screw and clamp, maximum of
      one for field wires entering enclosure, otherwise maximum of
      two.

7. Splicing and tapping of wires, allowed only at device terminals or
   terminal blocks.

8. Terminate 24V dc and analog signal circuits on separate terminal block
   from ac circuit terminal blocks.

9. Separate analog and dc circuits by at least 6 inches from ac power and
   control wiring, except at unavoidable crossover points and at device
   terminations.

10. Arrange wiring to allow access for testing, removal, and maintenance of
    circuits and components.


12. Conductors Carrying Foreign Voltages within a Panel:
   a. Route foreign voltage conductors into panel and land on a circuit
      blade disconnect type terminal block.
   b. Use wire with pink insulation to identify foreign voltage circuits
      within panel from terminal block on. Do not use wires with pink
      insulation for any other purpose.

13. Harness Wiring:
   a. 120V ac: No. 14 AWG, MTW.
   b. 24V dc: No. 16 AWG, MTW where individual conductors are
      used and Type TC shielded tray cable where shielded wire is used.

14. Panelwork:
   a. No exposed connections.
   b. Allow adjustments to equipment to be made without exposing
      these terminals.
   c. For power and control wiring operating above 80V ac or dc use
      covered channels or EMT raceways separate from low voltage
      signal circuits.

15. Plastic Wire Ducts Color:
   a. 120V ac: White.
   b. 24V dc: Gray.
   c. Communications Cables and Fiber Optic Jumpers: Orange.

16. Provide a communications plastic wire duct for communications cables
    and fiber optic cables between the communications devices in control
    panel and communications raceways. Design plastic wire duct design to
    take into account the minimum bending radius of the communications
    cable.

17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

I. Factory Finishing:

1. Furnish materials and equipment with manufacturer’s standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer’s standard finish color, or light gray if manufacturer has no standard color.
5. Steel Panels:
   a. Sand panel and remove mill scale, rust, grease, and oil.
   b. Fill imperfections and sand smooth.
   c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
   d. Sand surfaces lightly between coats.
   e. Dry Film Thickness: 3 mils, minimum.
   f. Color: Manufacturer’s standard.

2.11 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Part 3, Article Protection.
2. Manufacturers and Products:
   a. Northern Instruments; Model Zerust VC.
   b. Hoffmann Engineering; Model A-HCI.

2.12 SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer’s decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
   a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.

6. Conducting Tests:
   a. Provide special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
   d. Define simulation techniques in test procedures.
   e. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect), occurs.
   f. For PIC systems for which Engineer provides applications software, provide sufficient temporary software configuring to allow FDT and SSDT testing of these subsystems.

B. Unwitnessed Factory Test:

   1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
   2. Location: PIC System Integrator’s facility.
   3. Integrated Test:
      a. Interconnect and test PIC, except for primary elements and smaller panels.
      b. Exercise and test functions.
      c. Provide stand-alone testing of smaller panels.
      d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

   1. Notify Engineer of test schedule 4 weeks prior to start of test.
   2. Scope:
      a. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
      b. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PIC System Integrator’s facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
   a. Simulate each discrete signal at terminal strip.
   b. Simulate correctness of each analog signal using current source.
5. Operation of communications between PLCs and remote I/O and between PLCs and computers.
6. Failed Tests:
   a. Repeat and witnessed by Engineer.
   b. With approval of Engineer, certain tests may be conducted by PIC System Integrator and witnessed by Engineer as part of Functional Test.
7. Make following documentation available to Engineer at test site both before and during FDT:
   b. Master copy of FDT procedures.
   c. List of equipment to be tested including make, model, and serial number.
   d. Approved hardware Shop Drawings for equipment being tested.
   e. Approved preliminary software documentation Submittal.
8. Daily Schedule for FDT:
   a. Begin each day with meeting to review day’s test schedule.
   b. End each day with each meeting to review day’s test results and to review or revise next day’s test schedule.

2.13 MAINTENANCE OF PROGRAMMING EQUIPMENT

   A. Provide for maintenance of programming equipment while at Engineer’s office. Repair or replace failed equipment within 5 days of notice by Engineer.

PART 3 EXECUTION

3.01 EXAMINATION

   A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

      1. Proper installation.
      2. Calibration and adjustment of positioners and I/P transducers.
      3. Correct control action.
      4. Switch settings and dead bands.
      5. Opening and closing speeds and travel stops.
      6. Input and output signals.
3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers’ installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes.

D. Mechanical Systems:
   1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
   2. Plastic Tubing Support: Except as shown on Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
   3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
   4. Tubing and Conduit Bends:
      a. Tool-formed without flattening, and of same radius.
      b. Bend Radius: Equal to or larger than conduit and tubing manufacturer’s recommended minimum bend radius.
      c. Slope instrument connection tubing in accordance with installation details.
      d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
      e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
      f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
      g. Blow debris from inside of tubing.
      h. Make up and install fittings in accordance with manufacturer’s recommendations. Verify make up of tube fittings with manufacturer’s inspection gauge.
      i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.
      j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
      k. Provide separate support for components in tubing runs.
l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.

m. Keep tubing and conduit runs at least 12 inches from hot pipes.

n. Locate and install tubing raceways in accordance with manufacturer’s recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.

o. Securely attach tubing raceways to building structural members.

5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Owner and affected Subcontractors.

2. Notify Engineer of Performance Test schedule 4 weeks prior to start of test.

3. Engineer may actively participate in tests.

4. Engineer reserves right to test or retest specified functions.

5. Engineer’s decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.

2. Require PIC site representative to supervise and coordinate onsite PIC activities.

3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During preparation for Functional Test Part 1, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing Sequence:

1. Provide Functional Tests and Performance Tests for facilities as required to support staged construction and startup of plant.

2. Refer to article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of project milestones.

3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

E. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation. Divide Functional Test for each facility into two parts.

2. FT1: Performed by PIC System Integrator, Contractor, and package system vendors to test and document PIC, excluding Software Integrator provided applications software, is ready for operation. For PIC Subsystems for which Software Integrator provides applications software, provide sufficient temporary software configuring to allow testing of these subsystems.
   a. Loop/Component Inspections and Tests:
      1) These inspections and tests will be spot checked by Engineer.
      2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
      3) Provide space on forms for signoff by PIC System Integrator.
      4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
         a) Project name.
         b) Loop number.
         c) Tag number for each component.
         d) Checkoffs/Signoffs for Each Component:
            (1) Tag/identification.
            (2) Installation.
            (3) Termination wiring.
            (4) Termination tubing.
            (5) Calibration/adjustment.
         e) Checkoffs/Signoffs for the Loop:
            (1) Panel interface terminations.
            (2) I/O interface terminations with PLCs.
            (3) Hardwired interlocks.
            (4) Interfaces with other systems.
         f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
         g) Total loop operational.
         h) Space for comments.
5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLC I/O module and include the following:
   a) Project name.
   b) Loop number.
   c) Component tag number or I/O module number.
   d) Component code number for I&C elements.
   e) Manufacturer for I&C elements.
   f) Model number/serial number for I&C elements.
   g) Summary of Functional Requirements; for example:
      (1) Indicators and recorders, scale and chart ranges.
      (2) Transmitters/converters, input and output ranges.
      (3) Computing elements’ function.
      (4) Controllers, action (direct/reverse) and control modes (P, I, D).
      (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
      (6) I/O Modules: Input or output.
   h) Calibrations, for example, but not limited to:
      (1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
      (2) Discrete Devices: Actual trip points and reset points.
      (3) Controllers: Mode settings (P&ID).
      (4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
      (5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.

c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.

d. FDT-Repeat:
   1) Repeat FDT onsite with installed PIC equipment and software.
   2) As listed in PIC subsections, certain portions of FDT may not require retesting.
   3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.


3. FT2: Combined effort between Contractor, PIC System Integrator, package system vendors, and Software Integrator to confirm PIC, including applications software, is ready for operation.
   a. Prerequisite:
      1) Completion of Functional Test Part 1.
      2) Completion of Communication System Functional Test as described in Section 40 95 80, Network Communication Systems.
   b. Joint test with Software Integrator, PIC System Integrator, and package control system vendors. Repeat of FT1, except including Software Integrator provided PLC and SCS applications software. Plant interlocking and communications with PLCs, FOCS, and HMI tested on loop-by-loop basis.
   c. Test procedures provided by Software Integrator based on Loop specifications.
   d. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

F. Performance Test (PT) During and After Facility Startup:

1. Once a facility’s Functional Tests have been completed and that facility has been started up, perform jointly with Engineer and Software Integrator, Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.

2. Loop-specific and nonloop-specific tests same as required for FDT that entire installed PIC tested using actual process variables and functions demonstrated.

3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.

4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Determination of Ready for Operation: When Functional Test has been completed.
8. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 TRAINING

A. General:

1. Provide an integrated training program for Owner’s personnel.
2. Perform training to meet specific needs of Owner’s personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.
4. Provide instruction on one working shift(s) as needed to accommodate the Owner’s personnel schedule.
5. Owner reserves the right to reuse videotapes of training sessions.

B. Management Seminar:

1. Length: 1/2 day.
2. Location: Owner’s facility.
3. Objective: Provide overview for nonoperations and maintenance personnel for understanding the PIC.
4. Attended by management, engineering, and other nonoperations and nonmaintenance personnel.
5. Primary Topics:
   a. PIC Overview: How hardware and software are used for operation and control of facilities.
   b. Block Diagram Presentation of PIC: How and what information flows within system and what is done by each functional unit.
   c. Process/Operator Interface: Explanation and demonstration of how to use HMI PC to access displays, reports, and controls.
   d. Management-oriented explanation of data management displays and printouts.
   e. Walk-through of installed systems.

C. Operations and Maintenance Training:

1. General:
   a. Refer to specific requirements specified in PIC Subsections.
b. Include review of O&M data and survey of spares, expendables, and test equipment.

c. Use equipment similar to that provided.

d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.

2. Operations Training: For Owner’s operations personnel on operation of I&C components.

   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.

   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, AUTO/MANUAL control transfer, AUTO and MANUAL control, annunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.

3. Maintenance Training:

   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: One.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.

   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.
      5) Replacing lamps, chart paper, and fuses.
      6) I&C components removal and replacement.
      7) Periodic preventive maintenance.
3.05 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.06 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer’s recommendations.

3.07 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. Preparation for Testing and Functional Test Forms:
   a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
   b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
   c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.

2. Performance Test Sheet: Describe Performance Test for a given loop.
   a. List requirements of the loop.
   b. Briefly describe test.
   c. Cite expected results.
   d. Provide space for checkoff by witness

3. Control Panel Schedule.
4. Field Panel Schedule.

END OF SECTION
**LOOP STATUS REPORT—EXAMPLE FORMAT**  
Rev.06.05.92

Project Name: Newport News WTP  
Project No. WDC23456.C1

**FUNCTIONAL REQUIREMENTS:**

1. Measure, locally indicate, and transmit RAS flow to LP-10.
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.
3. Provide high RAS flow alarm on LP-10.

**COMPONENT STATUS** (Check and initial each item when complete)

<table>
<thead>
<tr>
<th>Tag Number</th>
<th>Delivered</th>
<th>Tag ID Checked</th>
<th>Installation</th>
<th>Termination Wiring</th>
<th>Termination Tubing</th>
<th>Calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE/FIT-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Feb-7-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>N.A.</td>
<td>May-6-90 VDA</td>
</tr>
<tr>
<td>FIC-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>Apr-4-90 DWM</td>
<td></td>
<td>May-4-90 VDA</td>
</tr>
<tr>
<td>FSH-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>Apr-4-90 DWM</td>
<td></td>
<td>May-7-90 VDA</td>
</tr>
<tr>
<td>FAH-10-2</td>
<td>Jan-12-90 DWM</td>
<td>Jan-12-90 DWM</td>
<td>Mar-5-90 DWM</td>
<td>Apr-4-90 DWM</td>
<td></td>
<td>May-7-90 VDA</td>
</tr>
<tr>
<td>FCV-10-2</td>
<td>Mar-2-90 DWM</td>
<td>Mar-2-90 DWM</td>
<td>Apr-20-90 DWM</td>
<td>Apr-30-90 DWM</td>
<td></td>
<td>May-16-90 VDA</td>
</tr>
</tbody>
</table>

**REMARKS:** None.

**Loop Ready for Operation**  
By: D.W. Munzer  
Date: May-18-90  
Loop No.: 10-2
**COMPONENT** | **MANUFACTURER** | **PROJECT**  
---|---|---  
Code: A7 | Name: Leeds & Northrup | Name: pH Element & Analyzer/Transmitter  
Name: pH Element & Analyzer/Transmitter | Model: 12429-3-2-1-7 | Serial #: 11553322  
Number: WDC30715.B2 | Name: UOSA AWT PHASE 3

| FUNCTIONS |
|---|---|---|---|---|---|
| | | | | | Action? direct / reverse |
| | | Scale: | 1-14 pH units | | Modes? P / I / D |
| Transmit/ Convert? Y | Input: | 1-14 pH units | | | SWITCH? N |
| | Output: | 4-20 mA dc | | | Unit Range: |
| | | | | | Differential: fixed/adjustable |
| | | | | | Reset? automatic / manual |

| ANALOG CALIBRATIONS | DISCRETE CALIBRATIONS |
|---|---|---|---|
| REQUIRED | AS CALIBRATED | REQUIRED | AS CALIBRATED |
| Input | Indicated | Output | Increasing Input | Decreasing Input | Number | Trip Point | Reset Pt. | Trip Point | Reset Pt. |
| 1.0 | 1.0 | 4.0 | 1.0 | 4.0 | 1.0 | 3.9 | 1.0 | N.A. | N.A. |
| 2.3 | 2.3 | 5.6 | 2.2 | 5.5 | 2.3 | 5.6 | 2.3 | N.A. | N.A. |
| 7.5 | 7.5 | 12.0 | 7.5 | 11.9 | 7.5 | 12.0 | 7.5 | N.A. | N.A. |
| 12.7 | 12.7 | 18.4 | 12.7 | 18.3 | 12.6 | 18.3 | 12.6 | N.A. | N.A. |
| 14.0 | 14.0 | 20.0 | 14.0 | 20.0 | 14.0 | 20.0 | 14.0 | N.A. | N.A. |


**NOTES:**
1. Need to recheck low pH calibration solutions.
2. Component Calibrated and Ready for Start-up

By: J.D. Sewell  
Date: Jun-6-92  
Tag No.: AIT-12-6[pH]
### CH2M HILL  I&C VALVE ADJUSTMENT SHEET—EXAMPLE  
**Rev.06.05.92**

<table>
<thead>
<tr>
<th>PARTS</th>
<th>Project Name: SFO SEWPCP</th>
<th>Project Number: SFO10145.G2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body</td>
<td>Type: Vee-Ball</td>
<td>Mfr: Fisher Controls</td>
</tr>
<tr>
<td></td>
<td>Size: 4-inch</td>
<td>Model: 1049763-2</td>
</tr>
<tr>
<td></td>
<td>Line Connection: 159 # ANSI Flanges</td>
<td>Serial #: 1003220</td>
</tr>
<tr>
<td>Operator</td>
<td>Type: Pneumatic Diaphragm</td>
<td>Mfr: Fisher Controls</td>
</tr>
<tr>
<td></td>
<td>Action: Linear – Modulated</td>
<td>Model: 4060D</td>
</tr>
<tr>
<td></td>
<td>Travel: 3-inch</td>
<td>Serial #: 2007330</td>
</tr>
<tr>
<td>Positioner</td>
<td>Input Signal: 3-15 psi</td>
<td>Mfr: Fisher Controls</td>
</tr>
<tr>
<td></td>
<td>Action: Direct - air to open</td>
<td>Model: 20472T</td>
</tr>
<tr>
<td></td>
<td>Cam: Equal percentage</td>
<td>Serial #: 102010</td>
</tr>
<tr>
<td>Pilot</td>
<td>Action:</td>
<td>Mfr:</td>
</tr>
<tr>
<td>Solenoid</td>
<td>Rating: None</td>
<td>Model: Serial #:</td>
</tr>
<tr>
<td>I/P Converter</td>
<td>Input: 4-20 mA dc</td>
<td>Mfr: Taylor</td>
</tr>
<tr>
<td></td>
<td>Output: 3-15 psi</td>
<td>Model: 10-T-576-3</td>
</tr>
<tr>
<td></td>
<td>Action: Direct</td>
<td>Serial #: 1057-330</td>
</tr>
<tr>
<td>Position Switch</td>
<td>Settings: Closed / Open 5 deg. rising</td>
<td>Mfr: National Switch</td>
</tr>
<tr>
<td></td>
<td>Contacts: Close / Close</td>
<td>Model: 1049-67-3</td>
</tr>
<tr>
<td></td>
<td>Serial #: 156 &amp;157</td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>Type: Pneumatic</td>
<td>Air Set Mfr: Air Products</td>
</tr>
<tr>
<td></td>
<td>Potential: 40 psi</td>
<td>Model: 3210D</td>
</tr>
<tr>
<td></td>
<td>Serial #: 1107063</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ADJUSTMENTS</th>
<th>Initial</th>
<th>Date</th>
<th>VERIFICATION</th>
<th>Initial</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Set</td>
<td>JDS</td>
<td>Jun-06-92</td>
<td>Valve Action</td>
<td>JDS</td>
<td>Jun-03-92</td>
</tr>
<tr>
<td>Positioner</td>
<td>JDS</td>
<td>Jun-06-92</td>
<td>Installation</td>
<td>JDS</td>
<td>Jun-03-92</td>
</tr>
<tr>
<td>I/P Converter</td>
<td>JDS</td>
<td>Jun-07-92</td>
<td>Tube Connection</td>
<td>JDS</td>
<td>Jun-04-92</td>
</tr>
<tr>
<td>Actual Speed</td>
<td>JDS</td>
<td>Jun-07-92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:** Valve was initially installed backwards.
Observed to be correctly installed May-25-92

Valve Ready for Start-up
By: J.D. Sewell
Date: Jun-07-92
Tag No.: FCV-10-2-1
**Demonstration test(s): For each functional Requirement of the loop:**

(a) List and number the requirement.
(b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance.
(d) Provide space for signoff.

### 1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

- FIT indicator should read zero.  
  **Jun-20-92 BDG**

### 2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression:

\[
Q(MGD) = 429H^{2/3} \quad (H = \text{height in inches of water over weir}).
\]

Vary \( H \) and observe that following.

2.a Reading of FIT indicator.  
  **Jun-6-92 BDG**

2.b Reading is transmitted to FI on LP-521-1  
  **Jun-6-92 BDG**

2.c Reading is transmitted and displayed to CCS.  
  **Jun-6-92 BDG**

<table>
<thead>
<tr>
<th>( H(\text{measured}) )</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Q(\text{computed}) )</td>
<td>0</td>
<td>47.96</td>
<td>135.7</td>
<td>251.7</td>
</tr>
<tr>
<td>( Q(\text{FIT indicator}) )</td>
<td>0</td>
<td>48.1</td>
<td>137</td>
<td>253</td>
</tr>
<tr>
<td>( Q(\text{LI on LP-521-1}) )</td>
<td>0</td>
<td>48.2</td>
<td>138</td>
<td>254</td>
</tr>
<tr>
<td>( Q(\text{display by CCS}) )</td>
<td>0</td>
<td>48.1</td>
<td>136.2</td>
<td>252.4</td>
</tr>
</tbody>
</table>

### Forms/Sheets Verified

<table>
<thead>
<tr>
<th>Forms/Sheets Verified</th>
<th>By</th>
<th>Date</th>
<th>Loop Accepted By Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loop Status Report</td>
<td>J.D. Sewell</td>
<td>May-18-92</td>
<td>By: J.D. Smith</td>
</tr>
<tr>
<td>Instrument Calibration Sheet</td>
<td>J.D. Sewell</td>
<td>May-18-92</td>
<td>Date: Jun-6-92</td>
</tr>
<tr>
<td>I&amp;C Valve Calibration Sheet</td>
<td>N.A.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panel No.</td>
<td>Service</td>
<td>Mounting</td>
<td>NEMA</td>
</tr>
<tr>
<td>------------</td>
<td>------------------</td>
<td>-------------</td>
<td>------</td>
</tr>
<tr>
<td>I10CP0001</td>
<td>Intake PLC</td>
<td>Freestanding</td>
<td>12</td>
</tr>
<tr>
<td>P20CP0001</td>
<td>Plant PLC</td>
<td>Freestanding</td>
<td>12</td>
</tr>
<tr>
<td>P20CP0002</td>
<td>Plant Server Rack</td>
<td>Freestanding</td>
<td>12</td>
</tr>
<tr>
<td>D55CP0001</td>
<td>98th St PRV PLC</td>
<td>Pedestal</td>
<td>4</td>
</tr>
</tbody>
</table>

Column Descriptions:
- **FDT**: Factory Demonstration test required.
- **Dimensions**: Maximum space available for panel.
- **SS**: Stainless Steel.
<table>
<thead>
<tr>
<th>Panel No.</th>
<th>Service</th>
<th>Mounting</th>
<th>NEMA</th>
<th>Dimensions H W D</th>
<th>FDT</th>
<th>Space Heater</th>
<th>Serv. Lights, Outlets</th>
<th>Environment</th>
<th>SS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I10FP0008  Note 1</td>
<td>Beaver Creek Downstream Level</td>
<td>Wall</td>
<td>4</td>
<td>12”x10”x5”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>No</td>
</tr>
<tr>
<td>I10FP0009  Note 1</td>
<td>Beaver Creek Upstream Level</td>
<td>Wall</td>
<td>4</td>
<td>12”x10”x5”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>No</td>
</tr>
<tr>
<td>I10FP0011  Note 1</td>
<td>Inlet Channel Level</td>
<td>Wall</td>
<td>4</td>
<td>12”x10”x5”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>No</td>
</tr>
<tr>
<td>I10FP0020</td>
<td>Raw Water Analyzer Panel</td>
<td>Wall</td>
<td>-</td>
<td>68”x56”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>Yes</td>
</tr>
<tr>
<td>P20FP0010  Note 3</td>
<td>Membrane Feed Analyzer Panel</td>
<td>Wall</td>
<td>-</td>
<td>68”x56”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>Yes</td>
</tr>
<tr>
<td>P20FP0020  Note 2</td>
<td>Membrane Filtrate Analyzer Panel</td>
<td>Wall</td>
<td>-</td>
<td>20”x20”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>Yes</td>
</tr>
<tr>
<td>P30FP0020  Note 1</td>
<td>Finished Water Pre-Chem Analyzer Panel</td>
<td>Wall</td>
<td>-</td>
<td>20”x20”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>Yes</td>
</tr>
<tr>
<td>P30FP0030  Note 1</td>
<td>Finished Water Post-Chem Analyzer Panel</td>
<td>Wall</td>
<td>-</td>
<td>20”x20”</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Indoor</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Column Descriptions:**
- FDT: Factory Demonstration test required.
- Dimensions: Maximum space available for panel.
- SS: Stainless Steel.

**Notes:**
1: Panel supplied by instrument manufacturer as a factory-built panel. Installed by PIC System Integrator.
2: Panel supplied by Westech and installed by PIC System Integrator.
3: Turbidity, pH, and temperature elements and transmitters supplied by Westech. Panel to be assembled, including Westech supplied instruments, and installed by PIC System Integrator.
SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.
D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

   1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Manifold, Three-Valve Equalizing:

   1. Type: For isolation and equalization of differential pressure transducers.
   3. Manufacturers and Products:
      b. Evans.

B. Pressure Gauge: For other than process variable measurement.

   1. Dial Size: Nominal 2-inch dial size.
   2. Accuracy: 2 percent of span.
   3. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.
   4. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
   5. Manufacturers and Products:
      a. Ashcroft Utility; Gauge Series 1000.
      b. Marsh; Standard Gauge Series.
      d. Acculite; Series 2000.

C. Valve, Needle:

   1. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
   2. Size: 0.020-inch orifice.
   3. Manufacturers and Products:
      a. Whitey; Model 21RF2.
      b. Hoke; 3700 Series.
D. ON/OFF Valves:

1. Type: Ball valve.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Flomite 7100 Series.

E. Regulating Valves:

1. Type: Needle valves, with regulating stems and screwed bonnets.
2. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Catalog No. RF or No. RS.
   b. Hoke; 3100 through 3300 Series.

F. Valve, Three-Way:

1. Type: Ball valve.
2. Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
3. Manufacturers and Products:
   a. Whitey; Series 41 through Series 43.
   b. Hoke; Selecto-Mite Series.

G. Valve, Four-Way:

1. Type: Four-way, two-position ball valve.
2. Materials:
   a. Body and Stem: Type 316 stainless steel.
   b. Handle: Black nylon.
3. Ball and stem bed, one-piece assembly.
4. Machined handle stops and directional nameplates.
5. Manufacturers and Products:
   a. Whitey; Series 457.
   b. Hoke; Multi-Mite Series.
H. Solenoid Valve, Two-Way:

1. **Type:** Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
2. **Materials:**
   a. **Body:** Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
   b. **Valve Seat:** Buna-N.
3. **Size:** Normally closed or opened, as noted.
4. **Coil:** 115V ac, unless noted otherwise.
5. **Solenoid Enclosure:** NEMA 4.
6. **Manufacturer and Product:** ASCO; Red Hat Series 8260.

I. Test Tap:

1. **Manufacturers and Products:**
   a. Imperial-Eastman; quick-disconnect couplings No. 292-P and caps No. 259-P.
   b. Crawford Fitting Co.; Swagelok quick-connects Series QC4 and caps QC4-DC.
   c. Parker; CPI Series precision quick couplings.

J. Copper Tubing and Fittings:

1. **Type K** hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
2. Alternatively, **Type K** soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on Drawings.
3. **Manufacturers:**
   a. Parker-Hannifin.
   b. Swagelok tube fittings.

K. Plastic Tubing and Fittings:

1. **Tubing:**
   a. Polyethylene capable of withstanding 190 psig at 175 degrees F.
   b. **Manufacturers and Products:**
      1) Dekoron; Type P.
      2) Imperial Eastman; Poly-Flo black instrument tubing.
2. Fittings:
   a. Type: Brass compression.
   b. Manufacturers and Products:
      1) Imperial Eastman; Poly-Flo tube fittings.
      2) Dekoron; E-Z fittings.

L. Stainless Steel Tubing: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed, as shown on Drawings.

M. Stainless Steel Fittings:

1. Compression Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Manufacturers and Products:
      1) Parker Flodar; BA Series.
      2) Swagelok tube fittings.
      3) Parker CPI tube fittings; Parker A-LOK dual ferrule tube fittings.

2. Socket Weld Type:
   a. Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
   b. Manufacturers:
      1) Cajon.
      2) Swagelok.
      3) Parker WELDLOK.

N. Tubing Raceways:

1. Cable tray systems complete with tees, elbows, reducers, and covers.
2. Size in accordance with manufacturer’s recommendations for intended service.
3. Materials: Galvanized steel or aluminum brass as recommended by manufacturer for designated service, unless otherwise shown on Drawings.
4. Manufacturers:
   a. Globetray.
   b. Cope.
2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Connection Type: Screw compression clamp.
   b. Compression Clamp:
      1) Complies with DIN-VDE 0611.
      2) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
      3) Guides strands of wire into terminal.
   d. Current Bar: Copper or treated brass.
   e. Insulation:
      1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
      2) Two funneled shaped inputs to facilitate wire entry.
   f. Mounting:
      1) Standard DIN rail.
      2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
      3) End Stops: Minimum of one at each end of rail.
   g. Wire Preparation: Stripping only permitted.
   h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
   i. Marking System:
      1) Terminal number shown on both sides of terminal block.
      2) Allow use of preprinted and field marked tags.
      3) Terminal strip numbers shown on end stops.
      4) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
      5) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.

2. Terminal Block, General Purpose:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30-amp.
   c. Wire Size: 24 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Test Sockets: One screw test socket 0.079-inch diameter.
   h. Manufacturer and Product: Entrelec; Type M4/6.T.
3. Terminal Block, Ground:
   a. Wire Size: 24 AWG to 10 AWG.
   b. Rated Wire Size: 10 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Electrically grounded to mounting rail.
   f. Manufacturer and Product: Entrelec; Type M4/6.P.

4. Terminal Block, Blade Disconnect Switch:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 10-amp.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body, orange switch.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.SNT.

5. Terminal Block Diode:
   a. Rated Voltage: 24V dc.
   b. Rated Current: 30 mA.
   c. Wire Size: 16 AWG.
   d. Manufacturer and Product: Phoenix Contact; ST-IN.

6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: LED diode 24V dc.
   h. Spacing: 0.512 inch, maximum.
   i. Manufacturer and Product: Entrelec; Type ML10/13.SFD.

7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   c. Wire Size: 22 AWG to 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Fuse: 0.25 inch by 1.25 inches.
   g. Indication: Neon lamp, 110V ac.
   h. Leakage Current: 1.8 mA, maximum.
   i. Spacing: 0.512 inch, maximum.
   j. Manufacturer and Product: Entrelec; Type ML10/13.SFL.

8. Terminal Block, Fused, 120V ac, High Current:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 35-amp.
c. Wire Size: 18 AWG to 8 AWG.
d. Rated Wire Size: 8 AWG.
e. Color: Gray.
f. Fuse: 13/32 inch by 1.5 inches.
g. Spacing: 0.95 inch, maximum.

9. Manufacturer and Product: Entrelec; Type MB10/24.SF.

B. Relays:

1. General:
   b. Relay Enclosure: Furnish dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Provide holddown clips.

2. Signal Switching Relay:
   a. Type: Dry circuit.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 5 amps at 28V dc or 120V ac.
   d. Contact Material: Gold or silver.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 0.9 watt (dc), 1.2VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Seal Type: Hermetically sealed case.
   k. Manufacturer and Product: Potter and Brumfield; Series KH/KHA.

3. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
   g. Expected Mechanical Life: 10,000,000 operations.
   h. Expected Electrical Life at Rated Load: 100,000 operations.
   i. Indication Type: Neon or LED indicator lamp.
   j. Push-to-test button.
   k. Manufacturer and Product: Potter and Brumfield; Series KUP.

4. Control Circuit Switching Relay, Latching:
   a. Type: Dual coil mechanical latching relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 28V dc or 120V ac.
5. Control Circuit Switching Relay, Time Delay:
   a. Type: Adjustable time delay relay.
   b. Contact Arrangement: 2 Form C contacts.
   c. Contact Rating: 10A at 30V dc or 277V ac.
   d. Contact Material: Silver cadmium oxide alloy.
   e. Coil Voltage: As noted or shown.
   f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
   g. Repeatability: Plus or minus 2 percent.
   h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
   i. Time Delay Setpoint: As noted or shown.
   j. Mode of Operation: As noted or shown.
   k. Adjustment Type: Integral potentiometer with knob external to dust cover.
   l. Manufacturer and Products: Potter and Brumfield; Series CB for 0.1-second to 100-minute delay time ranges, Series CK for 0.1-second to 120-second delay time ranges.

C. Power Supplies:

1. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs with independent supply failure status to PLC.

2. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

3. Provide output over voltage and over current protective devices to:
   a. Protect instruments from damage due to power supply failure.
   b. Protect power supply from damage due to external failure.


5. Mount such that dissipated heat does not adversely affect other components.

6. Fuses: For each dc supply line to each individual two-wire transmitter.
   a. Type: Indicating.
   b. Mount so fuses can be easily seen and replaced.

7. Manufacturer and Product: Allen-Bradley; Model 1606-XLS.
D. Intrinsic Safety Barriers:

1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.

2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.

2.04 I&C COMPONENTS

A. A03 Conductivity Element and Transmitter:

1. General:
   a. Function: Measure, indicate, and transmit conductivity of noted process liquid.
   b. Sensor Type: Probe with either electrode sensor.
   c. Parts: Element, transmitter, interconnecting cable, and expendables.

2. Performance:
   a. Process Liquid: As noted.
   b. Process Range: As noted.
   c. Accuracy: Plus or minus 0.5 percent of measured range.

3. Features:
   a. Temperature Compensation: Automatic thermocompensator for process liquid temperatures 0 degree C to 200 degrees C.

4. Element:
   a. Type: Electrode, unless otherwise noted.
   b. Electrode Material: Type 316 stainless steel or titanium, unless otherwise noted.
   c. Other Wetted Parts: Type 316 stainless steel or nonmetallic synthetic materials; manufacturer to confirm material compatibility with process liquid.
   d. Probe Constant: As required for noted process range.
   e. Process Connection: Insertion, compression fitting, 3/4-inch NTP, unless otherwise noted.
   f. Mounting Hardware: As recommended by manufacturer for specific application and as shown on Drawings.

5. Transmitter: Refer to Component Code A150 Analytical Indicating Transmitter, Two-Channel.

6. Manufacturer and Product: Hach; Model 3400 Series.
B. A07 pH Element and Transmitter:

1. General.
   a. Function: Measure, indicate, and transmit pH of process fluid.
   b. Parts: Element, analyzer/transmitter, interconnecting cable, and noted ancillaries.

2. Performance:
   a. Element:
      1) Measuring Range: Minus 2 pH to 14 pH.
      2) Operating Temperature: 0 degree C to 50 degrees C.
      3) Operating Pressure: 6.9 bar at 70 degrees C.
   b. Analyzer/Transmitter:
      1) Output Range: As noted.
      2) Accuracy: Plus or minus 0.02 pH units.
      3) Repeatability: Plus or minus 0.05 pH units.

3. Element:
   a. Process Connection: 1-inch NPT.
   c. Process Fluid: As noted.
   d. Wetted Materials: Compatible with process fluid, PEEK or Ryton.
   e. No field-replaceable parts, unless otherwise noted.
   f. Electrode Type: General purpose, unless otherwise noted.
   g. Mounting/Process Connections: Convertible, as shown on Drawings.

4. Consumables (for each unit provided):
   a. Chemicals: 1 pint each of buffer solution for pH 4, pH 7, and pH 10.
   b. Salt Bridge: One double junction salt bridge, containing ceramic inner junction, binary fill solution, and O-ring.
   c. Standard Cell Replacement Solution: One container, 500 milliliters pH.

5. Transmitter: Refer to Component Code A150 Analytical Indicating Transmitter, Two-Channel.


C. A10 Combustible Gas Element and Transmitter:

1. General:
   a. Function: Continuously monitor ambient air for lower explosive limit (LEL) of combustible hydrocarbon based gases. If and as noted, also monitor additional gases.
   b. Sensor Type: Infrared, unless otherwise noted.
c. Parts: Element, transmitter, controller, calibration kit, and ancillaries.

2. Performance:
   a. Range: 0 percent to 100 percent LEL.
   b. Repeatability: Plus or minus 2 percent of full scale.
   c. Long Term Drift (6 Months): Less than plus or minus 1 percent LEL.
   d. Response Time, t90: Less than 15 seconds.
   e. Temperature, Operating:
      1) Element/Transmitter: Minus 22 degrees F to plus 131 degrees F.
      2) Controller: 0 degree F to plus 122 degrees F.
   f. Humidity, Operating (Both Element/Transmitter and Controller): 5 percent to 95 percent relative humidity, noncondensing.

3. Element/Sensor:
   a. Number of Sensors: One, unless otherwise noted.
   b. Gas Monitored: Combustible gas. If additional gases specified, as noted.
   c. Combustible Gas Sensor Type: Infrared, unless otherwise noted.
   d. Sensor integral to transmitter, unless otherwise noted.
   e. Calibration cup.
   f. If remote sensor specified:
      1) Mount as follows:
         a) Wall, unless otherwise noted.
         b) Duct Mount: If noted.
      2) Remote calibration adapter.

4. Transmitter:
   a. LCD Display.
   b. Nonintrusive interface for functional, calibration, and alarm testing.
   c. Enclosure:
      1) Explosion proof, suitable for Class 1, Division 1, Group C and Group D; unless otherwise noted.
      2) NEMA 4X, Type 316 stainless steel.
      3) Minimum of four-wire entry holes.

5. Controller:
   a. Required, unless otherwise noted.
   b. Number of Channels: One, unless otherwise noted.
   c. LCD display and LED alarm lights.
   d. Keypad.
   e. Audible alarm.
   f. Enclosure:
      1) Rating: NEMA 4X.
      2) Mounting: Wall.
g. Backup Battery: If noted.

6. Power:
   a. Transmitter: 18V dc to 30V dc.
   b. Controller: 85V ac to 264V ac, 50/60-Hz, unless otherwise noted.

7. Signal Interfaces:
   a. Transmitter:
      1) Three SPDT relays rated for 230V ac at 5 amps resistive.
          a) Configured for warning and alarm levels, and unit fault.
      2) Analog Output: 4 mA to 20 mA dc analog output capable of driving 600 ohms at 24V dc.
      3) Digital Interface: If and as noted.
   b. Controller:
      1) Analog Output: 4 mA to 20 mA dc analog output capable of driving 600 ohms at 24V dc; one per channel.
      2) Discrete Outputs:
          a) SPDT relays rated for 230V ac at 5 amps resistive.
          b) Three per channel, plus one common fault.

8. Cables:
   a. If sensor remote from transmitter, provide cabling of required length.
   b. Between transmitter and controller, provide three-wire cable of required length. Cable suitable for analog signal transmission, and sensor power requirements.

9. Ancillaries:
   a. Calibration Kit:
      1) Accessories, including regulator and zero and span cylinders of gas(es) to be monitored.
      2) For remote mount sensor, provide calibration tubing. Length as required between sensor and transmitter. Not to exceed 100 feet.
      3) Device that allows operator to nonintrusively calibrate and adjust transmitter.
      4) Mounting Bracket for Transmitter and Remote Sensor: Required, unless otherwise noted.

10. Manufacturers and Products:
    a. MSA; Ultima XIR Gas Monitor and MSA Gasguard X Monitor.
    b. Sensidyne Sensor; Universal Transmitter and Controller.
    c. Scott; Model 4688-IR Combustible Gas Transmitter and Sentinel Series Monitor.
    d. Draeger; Polytron XX Ex Transmitter and Controller.
D. A16 Low Range Laser Turbidity Element and Transmitter:

1. General:
   a. Function: Continuously measure, indicate, and transmit a signal proportional to turbidity of a sample stream of process fluid.
   b. Type: Light scatter detection measurement using a 360-degree by 90-degree scatter photocell detector.
   c. Parts: Element, transmitter, interconnecting cable, mounting hardware, and expendables.

2. Performance:
   a. Detection Limit: 0.002 NTU.
   b. Repeatability: Plus or minus 1 percent or plus or minus 0.002 NTU, whichever is greater.
   d. Range: 0 NTU to 700 NTU.
   e. Output Range: As noted.
   f. Displayed Resolution: 0.0001 NTU.
   g. Initial Response Time: Within 30 seconds for a full-scale step change at 100 mL per minute.
   h. Optimal Flow: 200 mL to 500 mL per minute.
   i. Sample Temperature: 2 degrees C to 60 degrees C.
   j. Operating Temperature: 0 degree C to 50 degrees C.
   k. Operating Humidity: 5 percent to 95 percent, noncondensing.
   l. Accuracy:
      1) From 0 NTU to 40 NTU: Plus or minus 2 percent of reading or plus or minus 0.01 NTU, whichever is greater.
      2) From 40 NTU to 700 NTU: Plus or minus 10 percent of reading.

3. Element:
   a. General: Flow-through body using focused light and photocell to measure scattered light within the fluid.
   b. Low volume flow-through vial.
   c. Polystyrene body.
   d. Sealed head assembly that is removable without disturbing sample flow.
   e. Dimensions: 10 inches by 11 inches by 8 inches, nominal.

4. Transmitter: Refer to Component Code A150 Analytical Indicating Transmitter, Two-Channel.

5. Power Supply: Input: 100V ac to 230V ac, 50-Hz to 60-Hz, auto-selecting, 40 VA.

6. Cabling: As required.

7. Accessories and Expendables:
   a. Maintenance Kit: Four for project.
   b. Replacement Vial: Four for project.
c. Stablecal Calibration Set: Four for project.

8. Manufacturer and Product: Hach Company; Model TU5300 sc.

E. A25 Free Chlorine Residual Analyzer, Amperometric with pH and Temperature Element and Transmitter:

1. General:
   a. Function:
      1) Measure, indicate and transmit proportional analog signal for:
         a) Free residual chlorine.
         b) pH, where indicated.
         c) Temperature, where indicated.
   b. Type: Amperometric.
   c. Parts:
      1) Three-Electrode Amperometric Chlorine sensor.
      2) Chlorine sensor flow cell with integrated flow sensor.
      3) pH flow cell with grab sample port.
      4) Transmitter.
      5) Stainless steel panel.
      6) pH sensor with integral temperature sensor, where indicated.
      7) Consumables:
         a) Membrane replacement kit.
         b) Free chlorine electrolyte.

2. Performance:
   a. Measurement range: 0 ppm to 20 ppm chlorine.
   b. Free Chlorine:
      1) Low Limit of Detection (LOD): 30 ppb (0.03 ppm) or better.
      2) Limit of Quantitation (LOQ): 90 ppb (0.09 ppm) or better.
      3) Repeatability/precision: 30 ppb or 3 percent, whichever is greater.
      4) Response Time: Approximately 140 s for 90 percent change (T90) (at a stable T and pH).
      5) Interference: Monochloramine, Chlorine Dioxide, Ozone, and chalk deposits.
   c. Drift: Less than 10 percent with regular calibration (calibration will be weekly to quarterly depending on the application, given stable sample temperature and pH of water sample)
   d. Specificity/Selectivity: Nonspecific to a certain chlorine form, responds to any chlorine species and other oxidizers as noted in the interference section
e. Calibration Method: Customer has the option to use one (zero or slope) or two-point (zero and slope) calibration. Two-point calibration with chemical zero is recommended for chlorine concentration less than 0.5 ppm.

f. Verification Procedure: One-point process calibration (slope) against a standard reference method.

3. Environmental Requirements:
   a. Operating Ambient Temperature: 41 degrees F to 113 degrees F.
   b. Sample Requirements:
      1) Maximum Back Pressure: 0.5 bar, no pressure impulses.
      2) Flow 7.9 gallons to 10.6 gallons per hour optimal.

4. Transmitter:
   a. Refer to Component Code A150 Analytical Indicating Transmitter, Two-Channel.
   b. Include additional three channel 4 mA to 20 mA output expansion module where indicated.

5. Combination pH/Temperature Probe where Indicated:
   a. pH Range: 0 to 14.
   b. Temperature Range: 32 degrees F to 221 degrees F.
   c. Temperature Element: Platinum 1,000 ohm RTD.
   d. Accuracy: 0.1 percent of span.
   e. Repeatability: 0.1 percent of span or better.
   f. Corrosion resistant, fully immersible.

6. Features:
   a. Assembly includes a flow cell that integrates a flow meter and control valve.
   b. The chlorine sensor automatically compensates for temperature utilizing an embedded temperature sensor.

7. Wetted Materials:
   a. Chlorine Measuring Cell: PVC.
   b. Chlorine Sensor Body: PVC.
   d. pH Sensor Flow Cell: PVC.

8. Process Connections:
   a. Sample Inlet: 1/4-inch.
   b. Drain Connections: 1/2-inch.

9. Manufacturer and Product: Hach; CLF10sc with transmitter.

F. A150 Analytical Indicating Transmitter, Two-Channel:

1. General:
   a. Function: Interface with analytical probes provided by same vendor. Transmit probe readings to SCADA system.
2. Transmitter:
   a. Display:
      1) Display: Graphic LCD, with LED backlighting/transreflective.
         a) Display primary readout of probe data in engineering units.
      b) Auxiliary Readout:
         (1) Temperature.
         (2) Diagnostic warnings.
         (3) Error messages.
         (4) Other information.
   b. Ambient Conditions:
      1) Temperature minus 20 degrees C to 60 degrees C (minus 4 degrees F to 140 degrees F).
      2) Humidity: 0 percent to 95 percent, relative, noncondensing.
   c. Signal Interface:
      1) Analog Output:
         a) Two isolated 4 mA dc to 20 mA dc for load impedance up to 500 ohms.
         b) Outputs configured as needed to transmit readings from interfaced probes.
         c) For pH probes configure the second output to transmit measured sample temperature.
      2) Relay Outputs:
         a) Four SPDT (Form C); 5 amps resistive, 1,200W, 250V ac.
         b) Function:
            (1) Control: Settings for fail safe on/off, high/low phasing, set point, deadband, and on/off displays.
            (2) Alarm: Settings for fail safe on/off, low sample flow, high alarm point with deadband, low alarm point with deadband, and on/off relays.
            (3) Other functions if and as noted.
         c) Serial Communication: If and as noted.
   e. Mounting: Surface mount, unless otherwise noted.
   f. Mounting Hardware: Type 316 stainless steel hardware.
   g. Power Requirements: 110V ac to 240V ac plus or minus 10 percent, 50/60-Hz.
   h. Stainless steel equipment tag.
3. Accessories: Surge suppressor per Section 40 90 00, Instrumentation and Controls for Process Systems.

G. F3 Flow Element, Rotameter:
   1. For air or water service, unless otherwise noted.
   3. Direct-Reading Scale Length: 150 mm.
   4. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.
   5. Integral inlet needle valves.
   6. Manufacturer and Product: King Instruments; Series 7440.

H. F4 Flow Element and Transmitter, Electromagnetic:
   1. General:
      a. Function: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.
      b. Type:
         1) Electromagnetic flowmeter, with operation based on Faraday’s Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.
         2) Full bore meter with magnetic field traversing entire flow-tube cross section.
         3) Unacceptable are insert magmeters or multiple single point probes inserted into a spool piece.
      c. Parts: Flow element, transmitter, interconnecting cables, and mounting hardware. Other parts as noted.
   2. Service:
      a. Stream Fluid: As noted.
      b. Flow Stream Descriptions: If and as described below.
   3. Operating Temperature:
      a. Element:
         1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
         2) Process: 23 degrees F to 140 degrees F, typical, unless otherwise noted.
      b. Transmitter:
         1) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.
         2) Storage: Minus 40 degrees F to 158 degrees F, typical, unless otherwise noted.
4. Performance:
   a. Flow Range: As noted.
   b. Accuracy: Plus or minus 0.5 percent of rate.

5. Process Connection:
   a. Meter Size (diameter inches): As noted.
   b. Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
   c. Flange Material: Carbon steel, unless otherwise noted.

6. Power (Transmitter): 120V ac, 60-Hz, unless otherwise noted.

7. Element:
   a. Meter Tube Material: Stainless steel, unless otherwise noted.
   b. Liner Material:
      1) Hard rubber, unless otherwise noted.
      2) For potable water service, must have NSF approvals.
   c. Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
   d. Grounding Ring:
      1) Required, unless otherwise noted.
      2) Quantity: Two, unless otherwise noted.
      3) Material: Type 316 stainless steel, unless otherwise noted.
   e. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   f. Submergence:
      1) Temporary: If noted.
      2) Continuous (up to 10 feet depth), NEMA 6P/IP68: If noted.

8. Transmitter:
   a. Mounting: Surface (wall), unless otherwise noted.
   b. Display: Required, unless otherwise noted.
      1) Digital LCD display, indicating flow rate and total.
      2) Bi-directional Flow Display: Required, unless otherwise noted.
         a) Forward and reverse flow rate.
         b) Forward, reverse and net totalization.
   c. Parameter Adjustments: By keypad or nonintrusive means.
   d. Enclosure: NEMA 4X, minimum, unless otherwise noted.
   e. Empty Pipe Detection:
      1) Required, unless otherwise noted.
      2) Drives display and outputs to zero when empty pipe detected.

9. Signal Interface (at Transmitter):
   a. Analog Output:
      1) Isolated 4 mA dc to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.
      2) Supports Superimposed Digital HART Protocol: If noted.
10. Cables:
   a. Types: As recommended by manufacturer.
   b. Lengths: As required to accommodate device locations.

11. Built-in Diagnostic System:
   a. Features:
      1) Field programmable electronics.
      2) Self-diagnostics on flow sensor, signal converter, and process.
      3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value, etc.
      4) Initial flow tube calibration and subsequent calibration checks.

12. Factory Calibration:
   a. Calibrated in an ISO 9001 and NIST certified factory.
   b. Factory flow calibration system must be certified by volume or weight certified calibration devices.
   c. Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

13. Manufacturers and Products:
   a. Krohne (includes IFC 100 flow converter, NSF-certified); Enviromag 2000.

I. F127 Flow Switch, Thermal Dispersion:

1. General:
   a. Function: Monitor process gas or liquid flow rate. Provide contact closure when flow rate rises above or falls below setpoint.
   b. Type: Thermal dispersion.

2. Service:
   a. Process Fluid:
      1) Gas or liquid.
      2) Suitable for high viscosity and aerated fluids.
      3) Water, unless otherwise noted.
   b. Sensor Operating Temperature (process fluid): 32 degrees F to 140 degrees F.
   c. Operating Pressure: 150 psi (10 bar) at 77 degrees F (25 degrees C), derated at 1.667 psi (.113 bar) per degrees C above 25 degrees C.
3. Performance:
   a. Application: Flow, unless otherwise noted (liquid also available).
   b. Flow Setpoint:
      1) As noted, within the following ranges:
         a) Water: 0.04 fps to 3.0 fps.
   c. Response Time: 1 second to 10 seconds, typical, liquids.
   d. Time Delay: 0 second to 10 seconds, adjustable.
   e. Repeatability: Plus or minus 5 percent.
4. Probe:
   a. Twin tip, unless otherwise noted (spherical available).
   b. Materials: All wetted parts polypropylene/PPS or Polyvinylidene Fluoride.
   c. Supply Voltage: 24V dc.
   d. Process Connection: 3/4-NPT.
   e. Switch Type: SPDT 120V ac/120V dc at 1 amp.
   f. Electrical Connections: 22 AWG, three-wire, 10-foot length.
   g. Mounting Orientation: As shown.
   h. Indication: LED for flow status.
5. Manufacturer and Product: Dwyer; Series TDS.

J. L10 Level Transmitter, Direct Sensing, Flange Mounted:
1. General:
   a. Function: Measure level in a process vessel.
   b. Type:
      1) Capacitive differential pressure cell.
      2) Diaphragm for process fluid isolation.
      3) Flange mounting.
      4) Smart electronics.
      5) Two-wire device.
2. Service:
   a. Process Liquid: As noted.
   b. Process Temperature Range: Minus 20 degrees F to 400 degrees F, unless otherwise noted.
   c. Ambient Temperature Range: Minus 40 degrees F to 250 degrees F, unless otherwise noted.
   d. Humidity: 0 percent to 100 percent relative.
3. Performance:
   a. Range: As noted.
   b. Accuracy: Plus or minus 0.75 percent of span.
4. Features:
   a. Zero Suppression or Elevation: As noted.
   b. Damping: User-selectable; 0 second to 36 seconds time constant of analog output response to step change input.
c. Transmitter: Two-wire, powered from external power supply.
d. Zero and Span Adjustments: Local, external, noninteractive, unless otherwise noted.
e. Process Wetted Parts: Flanged Process Connection (Transmitter High Pressure Side):
   1) Flange Size/Type: 3 inch, Class 150, unless otherwise noted.
   2) Process Diaphragm: Type 316 stainless steel, unless otherwise noted.
   3) Mounting Flange: Stainless steel, unless otherwise noted.
   4) Mounting: Flush, unless otherwise noted.
   5) Extension Materials (if extension mount noted): Type 316 stainless steel, unless otherwise noted.
   6) Extension Length (if extension mount noted): As noted.
   7) Process Fill Fluid (High Pressure Side): Dow Corning Silicone 200, unless otherwise noted.
f. Reference Process Connection (Transmitter Low Pressure Side) Configuration (Differential, unless otherwise noted):
   1) Drain/Vent: Type 316 stainless steel.
   2) Flange Adapter: Stainless steel.
   3) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
   4) Sensor Fill Fluid (Low Pressure Side): Silicone, unless otherwise noted.
g. O-Ring: Glass-filled TFE.
h. Flange and Adapter Bolts: Type 316 stainless steel, unless otherwise noted.
i. LCD Meter: If noted.
j. Integral Transient Protection: If noted.
5. Signal Output Interface:
   a. 4 mA dc to 20 mA dc for load impedance 0 ohm to 580 ohms minimum at 24V dc supply voltage without load adjustment.
   b. Superimposed digital signal based on HART protocol.
6. Enclosure: NEMA 4X, polyurethane-covered aluminum, unless otherwise noted.
K. L18 Level Switch, Nonmercury:

1. General:
   a. Function: Actuate contact at preset liquid level.
   b. Type:
      1) Direct-acting, stainless steel float with enclosed, encapsulated switch and integral cable.
      2) Mercury free.

2. Service (Liquid): Wastewater, unless otherwise noted.

3. Performance:
   a. Setpoint: As noted.
   b. Differential: 8 inches maximum.
   c. Temperature: 32 degrees F (nonfreezing) to 160 degrees F.

4. Features:
   a. Entire Assembly: Watertight and impact-resistant.
   b. Float:
      1) Material and Size: 5.5-inch diameter polymer-coated, Type 316 stainless steel float.
      2) Buoyancy: 2 pounds.
   c. Cable:
      1) Length as noted or as necessary per mounting requirements.
      2) Plastic-jacketed cable, oil-resistant, and suitable for continuous service.
   d. Mounting: Pipe, unless otherwise noted.
      1) Pipe Mounting:
         a) Cable clamp, suitable for connection to 1-inch pipe.
         b) Pipe-to-wall bracket, suitable for connection to 1-inch pipe.
      2) Anchor Mounting Kit: If noted.
         a) 15-pound vinyl-coated cast-iron anchor.
         b) 1/8-inch, Type 316 stainless steel wire rope.
         c) Stainless steel cable clips.

5. Signal Interface:
   a. Switch Type: Magnetic reed.
   b. Switch Contacts:
      1) Isolated, rated at least 0.8 amp continuous at 120V ac.
      2) Contact Type: Either NO or NC, as required by application or as noted; or SPDT (NO and NC).

6. Accessories: As noted.

7. Manufacturers and Products:
   a. Siemens Water Technologies; Model 9G-EF Direct Acting Float Switch (B100).
   b. Contera; Model FS90.
L. L41 Level Element/Transmitter, Submersible, Water:

1. General:
   a. Function: Measure and transmit signal proportional to level.
      1) Type: Totally submersible pressure sensor (loop powered).
   b. Parts:
      1) Sensor.
      2) Interconnecting cable.
      3) Mounting system.
      4) Terminal box.
      5) Moisture protection.
      6) Other parts as noted.

2. Service:
   a. Fluid: Water, unless otherwise noted.

3. Performance:
   a. Process Range:
      1) As noted.
      2) Provide fixed factory range such that noted process range is between 40 percent and 80 percent of fixed factory range.
   b. Accuracy: 0.1 percent of full scale.
   c. Operating Temperature: Minus 10 degrees F to plus 175 degrees F.
   d. Compensated Temperature: 30 degrees F to 85 degrees F, unless otherwise noted.
   e. Overpressure:
      1) Full Scale Ranges up to 20 psi: 10X.
      2) Full Scale Ranges Above 20 psi up to 150 psi: 4X.

4. Features:
   a. Sensor:
      1) Ceramic pressure-sensing element.
      2) Housing: Titanium.
      3) NEMA 6/IP 68 rating (submersible).
      4) Anti-shock Delrin push on nose cone.
      5) Temperature measurement for density compensation with integrated Pt100 temperature sensor.
      6) Sensor range to be chosen not to exceed 80 percent of maximum for the specific pressure measuring range.
      7) Dimensions, Nominal:
         a) Diameter: 1 inch.
         b) Length: 5.75 inches maximum.
      8) Loop powered, 10V dc to 30V dc.
      9) Intrinsically Safe Approval: FM certified for use in Class 1 Division 1, Groups A, B, C, D, E, F, and G hazardous locations.
b. Interconnecting Cable:
   1) Length: As required.
   2) Polyurethane sheathed, unless otherwise noted.
   3) Kevlar strain relief cord.
   4) Integral vent tube.
   5) 1/2-inch NPT Conduit style cable connection.

c. Sensor Termination Enclosure: Terminal box required, unless otherwise noted.
   1) Enclosure: NEMA 4X.
   2) Houses such noted items as moisture protection module, and surge protector.

d. Accessories:
   1) Termination Enclosure.
   2) LCD Loop Powered Display.
   3) Moisture Protection Module: Required.
      a) Nitrogen filled reference.
   4) Surge Protector: Din rail, maximum discharge current of 20kA.
   5) Cable Hanger.

5. Signal Interface: 4 mA dc to 20 mA dc output, for load impedance of 0 ohm to 750 ohms, minimum for 24V dc supply without load adjustment. Class III, Division 1.


M. L43 Level Element/Temperature Element/Transmitter, Submersible, Water:

1. General:
   a. Function: Measure and transmit proportional signals.
      1) Type: Totally submersible pressure sensor (loop powered).
      2) Type: Totally submersible temperature sensor (loop powered).

   b. Parts:
      1) Sensor.
      2) Interconnecting cable.
      3) Mounting system.
      4) Terminal box.
      5) Moisture protection.
      6) Other parts as noted.

2. Service:
   a. Fluid: Water, unless otherwise noted.

3. Pressure Performance:
   a. Process Range:
      1) As noted.
2) Provide fixed factory range such that noted process range is between 40 percent and 80 percent of fixed factory range.

b. Accuracy: 0.1 percent of full scale.

c. Operating Temperature: 25 degrees F to plus 175 degrees F.

d. Proof Pressure:
   1) Full Scale up to 15 psi: 45 psi.
   2) Full Scale Ranges Above 20 psi up to 360 psi: 3X full scale, maximum 360 psi.

4. Temperature Performance:
   a. Accuracy: Plus or minus 0.5 degree F.
   b. Process Range: 25 degrees F to 175 degrees F.
   c. Span: As noted.

5. Features:
   a. Titanium construction.
   b. Loop powered, 10V dc to 30V dc.
   c. Signal Interface: Dual 4 mA to 20 mA output, three-wire configuration.
   d. Dimensions, Nominal:
      1) Diameter: 0.95 inch.
      2) Length: 6.5 inches, maximum.
   e. Interconnecting Cable:
      1) Length: As required.
      2) Polyurethane sheathed, unless otherwise noted.
      3) Kevlar strain relief cord.
      4) Integral vent tube.
   f. Accessories:
      1) LCD Loop Powered Display.
      2) Moisture Protection Module: Required.
         a) Nitrogen filled reference.
      3) Surge Protector: Din rail, maximum discharge current of 20kA.
      4) Sensor Termination Enclosure:
         a) Rating: NEMA 4X.
         b) Houses moisture protection module, surge protector, and LCD loop powered display for level and temperature.
         c) Cable Hanger.
         d) Anti-shock Delrin push on nose cone.

N. P4 Pressure Gauge:

1. General:
   a. Function: Local pressure indication.
   b. Type: Bourdon tube element.

2. Performance:
   a. Scale Range: As noted.
   b. Accuracy: Plus or minus 0.50 percent of full scale.

3. Features:
   a. Dial: 4-1/2-inch diameter.
   b. Pointer Vibration Reduction: Required, unless otherwise noted.
      Use the following method.
      1) Liquid filled gauge front, unless otherwise noted.
         a) Glycerine fill, unless otherwise noted.
   c. Case Material: Black thermoplastic, unless otherwise noted.
   d. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
      1) Stainless steel, unless otherwise noted.
   e. Pointer: Adjustable by removing ring and window.
   f. Window: Glass or acrylic, unless otherwise noted.
   g. Threaded reinforced polypropylene front ring.
   h. Case Type: Solid front with blow-out back.

4. Process Connection:
   a. Mounting: Lower stem, unless otherwise noted.
   b. Size: 1/2-inch MNPT, unless otherwise noted.

5. Accessories:
   a. Throttling Device: Required, unless otherwise noted.
      1) Type suitable for the intended service.
      2) Install in gauge socket bore.

6. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259.
   c. WIKA, Type 2XX.34.

O. P9 Pressure Transmitter:

1. General:
   a. Function: Measure pressure and transmit signal proportional to pressure.
   b. Type:
      1) Electronic variable capacitance or silicon strain gauge.
      2) Two-wire transmitter; “smart electronics.”
   c. Parts: Transmitter and accessories.
2. Performance:
   a. Range: As noted.
      1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
   b. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
   c. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
   d. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
   e. Humidity: 0 percent to 100 percent relative humidity.
   f. Hazardous Location Certifications: If and as noted.

3. Features:
   a. Type: Gauge pressure, unless otherwise noted.
   b. Adjustable damping.
   c. LCD indicator, unless otherwise noted.
      1) Display in either percent or engineering units, field configurable.
   d. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
      1) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
   e. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
   f. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
   g. Fill Fluid: Silicone, unless otherwise noted.

4. Process Connections:
   a. Line Size: 1/2 inch.
   b. Connection Type: FNPT.
   c. Direct/remote Diaphragm Seal: If and as noted.

5. Signal Interface:
   a. 4 mA dc to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.

6. Enclosure:
   a. Type: NEMA 4X.
   b. Materials: Coated aluminum, unless otherwise noted.
   c. Mounting bracket, unless otherwise noted.
      1) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
7. Accessories:
   a. Two-valve (isolate and vent) Stainless Steel Manifold: If noted.

8. Manufacturer and Product:
   a. Gauge Pressure Units: Rosemount; Model 3051 TG.

P. T21 Temperature Element and Transmitter, Wall Mount:

1. General:
   a. Function: Measure the temperature of space air, and transmit analog signal proportional to temperature.
   b. Type: RTD.
   c. Parts: Integral element and transmitter.

2. Service:
   b. Process Temperature Range: As noted.

3. Element:
   a. Type:
      1) Single-element, unless otherwise noted.
      2) Fixed, two-wire, RTD.
      3) Platinum, 1,000 ohm nominal at 0 degree C.
   b. Performance:
      1) Accuracy: Plus or minus 0.9 degree F.
      2) Features: Mounted within transmitter enclosure.

4. Transmitter:
   a. Ambient Operation Conditions.
      1) Temperature: Minus 40 degrees F to 185 degrees F.
      2) Relative Humidity: 0 percent to 95 percent, noncondensing.
   b. Type: Two-wire, powered by a remote power supply.
   c. Performance:
      1) Accuracy: Plus or minus 0.1 percent of output span.
      2) Response Time: Maximum 0.5 second 80 percent response time for 100 percent input step.
   d. Electrical Safety: Standard unless otherwise noted.
   e. Features:
      1) Automatic reference junction compensation.
      2) Mounted with sensing element within wall box surface mount enclosure.
   f. Signal Interface: 4 mA dc to 20 mA dc.
   g. Power: 24V dc external power supply.
   h. Enclosure:
      1) Materials: Thermoplastic.
      2) Mounting: Wall box surface mounting.
5. Manufacturer and Product:
   a. Moore Industries; Model T2X.
   b. “Or-equal.”

Q. Y40 Uninterruptible Power Supply System, Server Rack:

1. General:
   a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
   b. Location: Server Rack P20CP0001.
   c. Major Loads:
      1) PLC Panel P20CP0001.
      2) Server Rack P20CP0002.
      3) Workstations P20WKST9601, P20WKST9601.
   d. Major Parts: Inverter, battery charger, sealed battery.
   e. Agency Approvals: UL 1778 and UL 508.

2. Performance:
   a. Capacity: Plant Server Rack, P20UPS0001, 3000 VA.
   b. Input Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer’s standard, unless otherwise noted.
   c. Output Power:
      1) 120V ac single-phase, 60-Hz, unless otherwise noted.
      2) Connections: Manufacturer’s standard, unless otherwise noted.
   d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 9 minutes minimum, unless otherwise noted.
      2) Half Load: 20 minutes minimum, unless otherwise noted.
   f. Continuous no-break power with no measurable transfer time.
   g. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 5 percent or less.
   h. Output Voltage Regulation: Plus or minus 2 percent nominal.
   i. Operating Temperature: 0 degree C to 40 degrees C (32 degrees F to 104 degrees F).
   j. Operating Relative Humidity: 5 percent to 95 percent without condensation.

3. Features:
   a. Bypass Switch, make before break.
   b. Enclosure: 19-inch rack mount.
d. Alarm Contacts:
   1) Utility loss.
   2) Low battery.
   3) On bypass.


R. Y41 Uninterruptible Power Supply System, Panel Mount:

1. General:
   a. Function: Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
   b. Major Parts: Inverter, battery charger, sealed battery, extended battery.

2. Performance:
   a. Capacity:
      1) Intake Controls, I10UPS0001: 1000 VA.
      2) 98th Street PRV Controls, D55UPS0001: 600 VA.
   b. Input Power: 120V ac single-phase, 60 Hz.
   c. Output Power: 120V ac single-phase, 60 Hz.
   d. On-line Efficiency: 85 percent minimum, unless otherwise noted.
   e. Backup Runtime:
      1) Full Load: 9 minutes minimum, unless otherwise noted.
      2) Half Load: 20 minutes minimum, unless otherwise noted.
   f. Continuous no-break power with no measurable transfer time.
   g. Sine-Wave Output Voltage Total Harmonic Distortion (THD): 10 percent or less.
   h. Input Voltage Range: 90V ac to 145V ac.
   i. Output Voltage Regulation: 108V ac to 132V ac.
   j. Transfer Point Accuracy: Plus or minus 3 percent.
   l. Thermal Protection: Inside temperature greater than 60 degrees C.
   m. Operating Temperature: 0 degree C to 40 degrees C (32 degrees F to 104 degrees F).
   n. Operating Relative Humidity: 5 percent to 95 percent without condensation.

3. Included Options:
   a. All necessary cables.
   b. Ethernet/IP interface.
   c. Dry Alarm Contacts, 1 amp at 24V dc:
      1) On Battery.
      2) Low Battery.
      3) Fault.
d. Bypass switch: Panel builder to incorporate external bypass switch design as described in Allen-Bradley document 34348. UPS bypass switch to be mounted inside panel.

4. Mounting: Floor mount or heavy-duty DIN rail.

5. Manufacturer and Product: Allen-Bradley; 1609 Series.

S. Y50 Programmable Logic Controller System:


3. Digital Input Module:
   a. 120V ac Allen-Bradley; Model 1756-IA16I.
   b. 24V dc Allen-Bradley; Model 1756-IB16.


5. Analog Input Module: Allen-Bradley; Model 1756-IF8IH.

6. Analog Output Module: Allen-Bradley; Model 1756-OF8H.

7. Ethernet Communication Module: Allen-Bradley; 1756-EN2TR.


T. Y51 Compact Programmable Logic Controller System:

1. Control Processor: Allen-Bradley; Model 5069-L340ER.

2. Digital Input Module:
   a. 120V ac Allen-Bradley; Model 5069-IA16.
   b. 24V dc Allen-Bradley; Model 5069-IB16.


6. Ethernet Communication Module: Allen-Bradley; 5069-EN2TR.

7. Address Reserve Module: 5069-ARM.

8. End Caps: Allen-Bradley; Model 5069-ECR.


10. Field Potential Distributor: Allen-Bradley; Model 5069-FPD.

U. Y52 Micro Programmable Logic Controller System:

2.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.

1. Instrument List Summary.
2. Instrument Option Sheets.
3. PLC Equipment List.
4. PLC Input/Output List.

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<td>Level/Temp</td>
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<td>Level/Temp</td>
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## Component Code L10 - Option Sheet

**Level Transmitter, Direct Sensing, Flange Mounted**

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<td>4091-275G</td>
<td>SN</td>
<td>4 feet 5 inches above floor</td>
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<td>08-N-031</td>
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**Component Code A7 - Option Sheet**

**pH Element**

**PHASE IV BEAVER CREEK WATER SUPPLY**

**INSTRUMENTATION AND CONTROL FOR PROCESS SYSTEMS**

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### Component Code F127 - Option Sheet
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<td>400003</td>
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## Component Code L41 - Option Sheet

**Level Element/Transmitter, Submersible**

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INSTRUMENTATION AND CONTROL COMPONENTS

40 91 00 SUPPLEMENT - 1
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FIELD POWER DISTRIBUTION MODULE

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DECEMBER 2019 ©COPYRIGHT 2019 CH2M HILL
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SECTION 40 95 80
NETWORK COMMUNICATION SYSTEMS

PART 1  GENERAL

1.01 SUMMARY

A. The Contractor is responsible for:

1. Furnishing materials, labor, and equipment in accordance with these Specifications and the accompanying Drawings.
2. Complete systems in accordance with the intent of these Contract Documents.
3. Coordinating the details of facility network equipment and construction for other specification divisions that affect the network communications system work covered under this division.
4. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional system.

B. This Section specifies the requirements necessary to furnish, install, identify, and test products and materials listed below.

1. Plant control system network including:
   a. Fiber optic cable.
   b. CAT6 cable.
   c. Network interface panels.
   d. Network switches.
   e. Patch cords, connectors, and required accessories.
2. Facility wireless communication system including:
   a. Wireless LAN transmitter/receivers.
   b. Wireless LAN antenna.
3. Communications System Testing:
   a. On the reel fiber optic cable testing.
   b. CAT6 cable system testing.
   c. Fiber optic cable system testing.
   d. Communication System(s) functional tests.
4. Drawings and submittals.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this Section:

2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
6. Internet Engineering Task Force:
   a. RFC 2544 benchmarking methodology for network interconnect devices.
   b. RFC 6349 Framework for TCP Throughput Testing.
9. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
10. Telecommunications Industry Association (TIA):
    b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
    c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
    d. 568-C.3, Optical Fiber Cabling Components Standard.
    e. 598, Optical Fiber Cable Color Coding.
    f. 606, Administration Standard for Commercial Telecommunications Infrastructure.
11. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
    d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
1.03 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. AUI: Attachment Unit Interface.

C. CAT6: Category 6 Network Cable.

D. dB: Decibel.

E. DNI: Desktop Network Interface.

F. EMB: Effective Modal Bandwidth.

G. ETL: Electrical Test Laboratories.

H. FDDI: Fiber Distributed Data Interface.

I. FIM: Facilities Information Management.

J. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

K. FOCS: Fiber Optic Communication System.

L. FOIRL: Fiber Optic Inter Repeater Link.

M. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

N. Hybrid Cable: Cable containing more than one type of fiber.

LAN: Local Area Network.

LIMS: Laboratory Information Management System.

m: Micrometer.

Mbps: Megabits per Second.

Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

Megahertz (MHz): One million cycles per second.

MHz: Megahertz.

micro: x 10^-6.

Micron: Micrometer or one millionth meter.

MIS: Management Information System.

n, nano: x 10^-9.

N: Newton.

Network Interface Panel.

nm: Nanometer—unit of measure equal to one billionth meter.

OFL: Over-filled Launch.

Nonconductive Optical Fiber Cable.

Nonconductive Optical Fiber Plenum Cable.

Nonconductive Optical Fiber Riser Cable.

Optical Loss Test Sets.

Optical Time Domain Reflectometer.

Outside Vapor Deposit.

Process Instrumentation and Control.

Plenum: Air return path of central air handling system, such as open space above suspended ceiling.
MM. POE: Power over Ethernet.

NN. RLM: Restricted Mode Launch.

OO. ROL: Reverse Oscillation Lay.

PP. SPC: Super Physical Contact.

QQ. UPC: Ultra Physical Contact.

RR. UPS: Uninterruptible Power Supply.

SS. V ac: Volts Alternating Current.

TT. WAN: Wide Area Network.

UU. CCTV: Closed circuit television.

1.04 SYSTEM DESCRIPTION

A. This Section covers requirements for communication networks.

1. Network(s) will be used by PIC to distribute data and coordinate Owner’s operations.
   a. FOCS: Function of FOCS is to transmit digital data between network nodes over fiber media. Requirements listed identify minimum acceptable system performance.
   b. CAT6: Function of CAT6 is to transmit digital data between network nodes over copper media. Requirements listed identify minimum acceptable system performance.

1.05 SUBMITTALS

A. Action Submittals:

1. Site Layout Diagram Showing:
   a. Access holes, with identification.
   b. Abovegrade cable routings, with pole and cable identification.
   c. Belowgrade conduit routings between access holes and buildings, with conduit counts and identification.
   d. Cable routings to patch panels, fiber centers, or network nodes, with cable and node identification.

2. Cable Schedule Showing:
   a. Cable identification.
   b. Individual conductor identification.
   c. Fiber counts for each fiber cable and identification of used fiber pairs.
d. Cable length and attenuation, with two connector pairs and no splice(s), based on TIA 568-C.3, Annex H.

3. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.

4. Communications and Digital Networks Diagrams:
   a. Scope: Includes site network schematic diagrams and detailed point to point interconnection diagrams for plant wide Ethernet networks and I/O networks including adjustable frequency drives and digital power monitors.
   b. Show:
      1) Interconnected devices, both passive and active.
      2) Device names and numbers.
      3) Terminal numbers.
      4) Communication Media: Type of cable.
      5) Connection Type: Type of connector.
      6) Node and device address numbers.
      7) Wire and cable numbers and colors.
      8) Duct banks, vaults and access holes.

5. Submit electronic copies of Drawings in current AutoCad version.

B. Informational Submittals:

1. Manufacturer’s statement that installer is certified to perform installation Work.

2. Subcontractor Qualifications:
   a. Network Communications Subcontractor: Minimum of 5 years’ experience providing, integrating, installing, and commissioning of similar systems.
      1) Statement of Experience: List of at least five data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Owner’s name, address, telephone number, and name of current operations supervisor or other contact.
         b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
         c) System block diagram.
         d) Dates when contract was signed, equipment was delivered, and system was accepted by Owner. Also, include originally scheduled completion date and if different from actual date, explain why.
e) Approximate value of listed systems provided in dollars.

f) Detailed horizontal and riser routing.

b. Network Communications Subcontractor’s Site Representative: Minimum of 5 years’ experience installing similar systems.

c. Qualification of Personnel:
   1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.
   2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
      a) Fiber optic cable handling and placement techniques.
      b) Fiber optic splicing and installation of connections.
      c) Attenuation testing procedures.
      d) CAT6 cable installation and testing procedures.

d. Owner acceptance of Network Communications Subcontractor does not exempt Network Communications Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.

e. Sample of Network Test Report, minimum 10 pages that Contractor generated in a previous project.

f. Testing and acceptance plan, 30 days prior to beginning of testing.

g. Network cable and component Tests:
   1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
   2) Final Test Procedures: Proposed test procedures, forms, and checklists.

h. Test Documentation: Signed off test results for FOCS, and CAT6 networks.

i. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

3. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.

4. Manufacturer’s suggested installation practice.

5. Submit structural calculations, load tests, and other materials verifying anchorage and bracing capacity shown on submitted anchorage and bracing design drawings for components, distribution systems, and equipment are adequate for project specific loads. Submit as required by Section 01 88 15, Anchorage and Bracing. Calculations shall be stamped by an Engineer licensed in the State of Oregon.

6. Provide results of the preliminary facility wireless communication system propagation study for approval prior to final installation of facility wireless communication system.
7. Provide results of the final facility wireless communication system propagation study following final installation of facility wireless communication system.

8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable:

1. Outside, Underground/Submerged: Minus 40 degrees C to 70 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 70 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 70 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. CAT6 Cable: In accordance with Section 26 05 05, Conductors.

C. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 70 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Fiber:
   a. Cable:
      1) ISO 9001 or QF TL 9000 registered, whichever applies to material.
      2) Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
   b. Housing: ISO 9001 and QF TL 9000 registered.
   c. Connector:
      1) ISO 9001 or QF TL 9000 registered.
      2) Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
   d. Jumper Cable: ISO 9001 and QF TL 9000 registered.
2. **CAT6:**
   a. **Cable:** In accordance with Section 26 05 05, Conductors.
   b. **RJ-45 Connector:** In compliance with ISO-8877 and TIA 568 standards.

B. **Installer Qualifications:**
   1. Individuals with at least 5 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
   2. Certified by fiber cable manufacturer.

C. **Tester Qualifications:** Individuals with at least 5 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
   1. **Technician:** Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
      a. Manufacturer of fiber optic cable and fiber optic connectors.
      b. Manufacturer of test equipment used for field certification.
      c. Other independent training organizations acceptable to Owner.

D. **Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.**

1.08 **SPECIAL GUARANTEE**

A. **Provide manufacturer’s extended guarantee or warranty,** with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this Section found defective during a period of 15 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work shall be as specified in General Conditions.

1.09 **EXTRA MATERIALS**

A. **Furnish, tag, and box for shipment and storage the following materials:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumpers of each length needed</td>
<td>Three</td>
</tr>
</tbody>
</table>

B. **Delivery:** In accordance with Section 01 61 00, Common Product Requirements.
PART 2 PRODUCTS

2.01 FIBER OPTIC CABLE

A. Type 1:
   1. Single Mode optical fibers for use in the backbone distribution subsystem shall meet or exceed requirements of TIA 568-C.3, including the following specifications:
      a. Standards:
         1) Cable: IEEE 1222.
      b. Assembly: Core of individually tight-buffered fibers surrounded by a nonmetallic sheath.
      c. Approximate Diameter: 0.383 inch.
      d. Minimum Loaded Bending Radius (Dynamic): 8 inches.
      e. Minimum No-Load Bending Radius (Static): 4 inches.
      f. Optical Fibers:
         1) Corning; SMF-28e, “or-equal.”
         2) Maximum Individual Attenuation:
            a) 0.40 dB/km at 1,310 nm.
            b) 0.30 dB/km at 1,550 nm.
      g. Number of Strands/Fibers: 12.
      h. Manufacturer and Product: AFL Communications; Mini-Span 383 ADSS.

2.02 CAT6 CABLE

A. Supplied under Section 26 05 05, Conductors.

2.03 SERVER RACK

A. Function: Provides secure place to terminate fiber optic cables, mount rack mounted network equipment, and computers.

B. Location: Membrane Building, P20CP0002.

C. Equipment Rack:
   1. Material: Aluminum.
   2. Finish: Black.
   3. Removable side panels.
   4. Perforated metal front door, double perforated metal rear door.
   5. Dimensions: 23.6 inches by 40.3 inches by 79.3 inches.
6. Accessories:
   a. Cable Manager: Include cover. Provide horizontal cable management above patch panels and switches with a minimum of one rack-mount unit of cable management for every two units of switches and patch panels. Provide vertical cable management along both sides of the rack.
   b. Installation Kit: For concrete floor including anchors, studs, nuts and washers.


D. Fiber Patch Panel:

1. Compartments: Two; one for fiber optic cables, one for jumpers to individual equipment.
2. Coil Former: Former to wind slack cable around, provides controlled long radius bends.
3. Connectors: Minimum 4 LC style single mode pigtail connectors for entry and exit.
   a. Use for splicing preterminated pigtails to field cables.
   b. Pigtail Strands: 12.
   c. Pigtail Length: 3 meters.
   d. Each individual fiber shall be color coded in accordance with TIA 598.
4. Mountings: Suitable for permanent attachment including wall stand-off brackets.
5. Cable Strain Relief: Provide strain relief for each fiber cable.
6. Splice Tray:
   a. Securely organize and provide physical protection without stress on fibers for both single-mode and multimode individual and ribbonized fiber splices.
   b. Accommodate fusion splice, fusion splice with heat-shrink sleeve or mechanical sleeve, and mechanical splice part.
   c. High-precision molded construction that holds and protects actual splice thus eliminating need for extra splice protection parts.
   d. Provide positive holding action for maximum splice protection during installation and operation.
7. Manufacturers and Products:
   a. Ortronics, Model Numbers:
      1) Fiber Patch Panel: OR-FC02U-P.
      2) Fiber Adapter Panel: OR-OFP-LCD12LC.
      3) Blank Patch Adapter: OR-HDFP-Blank.
2.04 FIELD FIBER PATCH PANEL

A. Function: Provides secure place to terminate fiber optic cables.

B. Location: Intake Building, I10FPP0001.

C. Patch Panel:
   1. UL 1863 certified.
   3. Connectors: LC style single mode pigtail connectors for entry and exit.
      a. Use for splicing preterminated pigtails to field cables.
      b. Pigtail Strands: 12.
      c. Each individual fiber shall be color coded in accordance with TIA 598.
   4. Compatible with fiber optic cable specified in Article Fiber Optic Cable.
   5. Manufacturer and Product: Hirschmann; MIPP.

2.05 DIN RAIL INDUSTRIAL NETWORK SWITCH

A. Application:
   1. Intake:
      a. I10NSW9701.
      b. I10NSW9702.

B. General:
   1. UL 508 safety rating.
   2. Up to 16 port connections.
   3. Serial configuration port.
   4. Configurable alarm contact.
   5. Provide ports for each switch application as shown on Drawings.

C. Features:
   1. Fully Managed:
      a. SNMP v1, v2, v3.
      b. Web browser management.
      c. Detailed ring map and fault location charting.
      d. Ethernet Ring with a maximum of 30 ms healing time.
      e. IGMP auto-configuration.
      f. VLAN management.
      g. RSTP.
      h. IGMP.
i. DHCP.

j. Trunking and port mirroring.

k. N-Ring technology with 30 ms healing.

l. Ethernet/IP CIP Messaging:
   1) VLAN supporting IEEE 802.1Q.
      a) Port rate limiting.

m. Broadcast storm filtering.

n. Command line interface.

D. Ports:
   1. Ethernet: 10/100TX RJ45 connectors.
   2. Auto sensing.

E. Mounting: DIN rail.

F. Power Inputs: Two.

G. Certification: UL.

H. Mean Time Between Failures: 1 million hours.

I. Environmental:
   1. Operating Temperature: Minus 20 degrees C to 60 degrees C.
   2. Operating Humidity: 5 percent to 95 percent (noncondensing).

J. Power Supply:
   1. 24V dc.

K. Manufacturer and Product: N-Tron; 708TX (8-port) or 716TX (16-port).

2.06 RACK MOUNTED NETWORK SWITCH

A. Application:

B. General:
   1. UL 508 safety rating.
   2. Up to 24 port connections.
   3. Three slots, allowing a mix of port types.
   4. USB configuration port.
   5. Configurable alarm contact.
6. On board temperature sensing.
7. Provide port modules and transceivers as required for each switch application as shown on Drawings.

C. Features:

1. Fully Managed:
   a. Jumbo frame support.
   b. SNMP v1, v2, v3.
   c. Web browser management.
   d. Detailed ring map and fault location charting.
   e. Ethernet Ring with a maximum of 30 ms healing time.
   f. IGMP auto-configuration.
   g. VLAN management.
   h. RSTP.
   i. IGMP.
   j. DHCP.
   k. Trunking and port mirroring.
   l. N-Ring technology with 30 ms healing.
   m. Ethernet/IP CIP Messaging:
      1) VLAN supporting IEEE 802.1Q.
         a) Port rate limiting.
   n. Broadcast storm filtering.
   o. Command line interface.

D. Power: Redundant AC power supplies.

E. Port Modules:

1. SFP Module:
   a. Gigabit Ethernet: Slide-in module with 8BaseFX to 1,000BaseFX single mode fiber ports
   b. Provide enough port modules for 25 percent unused ports.
   c. Manufacturer and Product: N-Tron; NT24k-SFP8.
2. TX Module:
   a. Gigabit Ethernet: Slide in module with 8BaseT to 10/100/1000BaseT module.
   b. ESD and surge protection diodes on all copper ports.
   c. Provide enough port modules for 25 percent unused ports.
   d. Manufacturer and Product: N-Tron; NT24k-TX8.

F. Fiber Transceivers:

1. 1,000BaseLX singlemode fiber SFP pluggable mini-GBIC transceiver.
2. Provide required number of transceivers at each switch.
3. Spares: Provide two spares per switch.
4. LC connectors.

G. Filler Panel: Required for vacant module slots.

H. Mounting: 19-inch rack, 1U.

I. Environmental:

1. Operating Temperature: Minus 40 degrees C to 85 degrees C.
2. Operating Humidity: 5 percent to 95 percent noncondensing.
3. Shock: 50 g at 10 ms.
4. Vibration/Seismic: 30 g, 10 to 200 equals Hz, triaxial.
5. Internal temperature sensor.

J. Weight: 12.85 pounds.

K. Mean Time Between Failures: Greater than 1,000,000 hours.

L. Manufacturer and Product:


2.07 CONNECTORS

A. General:

2. LC connectors.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   b. Polarizing key on duplex connector systems.
5. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.75 dB per connector pair.
6. Manufacturer: AMP.

2.08 PATCHCORDS

A. Fiber:

1. General:
   a. In accordance with TIA 568-C.3.
b. Function: Connect fiber centers to network nodes, such as computer workstations.
c. Fiber Characteristics: In accordance with requirements for fiber optic cable.

2. Cable Configuration:
   a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
   b. Protected with Kevlar strength members and enclosed in thermoplastic jacket.
   c. Length: Standard, to meet requirements shown.

3. Connectors:
   a. As required by Article Connectors.
   b. On-Axial Pull Strength: 33 N.
   c. Normal-to-Axial Pull Strength: 22 N.

4. Cable Rating: OFNR or OFNP.
5. Color: Per standards or as indicated.

6. Measured for insertion loss with the following values for each connector:
   a. Typical of 0.3 dB and maximum of 0.5 dB.

B. Copper:

1. General:
   a. In accordance with TIA 568-C.2, UL 94, ISO 11801.
   b. Function: Interconnection between server rack equipment in P20CP0002.

2. Cable Configuration:
   a. Conductors: 24 AWG stranded copper.
   b. Cable Core: Four unshielded twisted pair.
   c. Jacket: Polyvinyl chloride (PVC).
   d. Plug: Eight position RJ-45 modular plug.
   e. Length: Standard, to meet requirements shown.

3. Color and quantity:
   a. Server Cables: Black, five per server.
   b. Firewall Cables:
      1) Protected side: Green, one per firewall.
      2) Outward facing: Red, one per firewall.
   c. Spare Cables: Black, five.
2.10 DATA AND TELEPHONE OUTLETS

A. CAT6 Outlet/Connector:
   1. Comply with FCC Part 68.5 and TIA/EIA 568-B.2-1 Category 6.
   2. UTP outlet/connector shall be UL 1863 listed, nonkeyed, four-pair, constructed of high impact rated thermoplastic housing, third-party verified, and shall comply with TIA/EIA Category 6 requirements.
   3. Terminate using a 110 style PC board connector, color-coded for both T568A and T568B wiring. Wire each jack T568A or as indicated.
   5. Cover Plates: Comply with UL 514C, and TIA/EIA 568-B.1; flush design constructed of high impact thermoplastic material. Provide stenciled lettering for voice and data circuits using thermal ink transfer process.
   6. Color Coding: Provide data and telephone outlets color coded by network function indicated on Drawings:
      a. SCADA Network: Blue.
      c. Telephony: White.

2.11 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PROTECTION DURING CONSTRUCTION

A. Protect products from the effects of moisture, corrosion, and physical damage during construction.

3.02 PREPARATION

A. Conduit:
   1. Ensure installed conduit system conforms to fiber optic system requirements, including:
      a. Conduits: Size and number.
      b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables may be installed without exceeding manufacturer’s limitations.
      c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
2. **Spare Conduit:**
   a. No cables shall be pulled into spare conduit.
   b. 100 percent spare conduit capacity required for buried conduit only. For example, for every conduit with one or more cables in it, there shall be one spare equal-size conduit with no cables.

3. **Expansion Plugs:** Seal conduit to stop ingress of water and grit with fabricated expansion plugs.

4. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

### 3.03 INSTALLATION

**A. Fiber Optic Cable:**

1. Specified fiber counts, routing, origination, and terminating points are indicated on Drawings.
2. Installation by manufacturer’s certified installer.
3. Install cables in accordance with manufacturer’s requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer’s specification.
   c. Not bent to a radius below manufacturer’s minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.
5. **Cables per Conduit:** In accordance with NFPA 70 NEC conduit fill limitations.
6. If calculation indicates cable will attenuate signals more than 8 dB, reroute may be allowed if approved by Engineer.
7. **Splices:**
   a. Install fiber optic cables with splices above grade in buildings, protected by splice housings as shown.
   b. Fusion splice fibers using apparatus applicable to type and size of fiber being spliced. Insert loss of splicing unit shall not exceed 0.2 dB on single-mode fibers and 0.25 dB on multimode fibers.
8. **Connector:** Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
9. **Identification:**
   a. Identify cable on both ends, in access holes, and pull points.
   b. In accordance with TIA 606.
10. **Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.**
11. **Access Holes:**
    a. Provide supports for cables in access and handholes at minimum 600 mm centers alongside.
b. While maintaining minimum bend radius, lace cables neatly to supports to keep them out of way of personnel.

B. CAT6 Cable:
   1. Specified cable counts, routing, origination, and terminating points are indicated on Drawings.
   2. Installation by certified installer.
   3. Install cables in accordance with manufacturer’s requirements.
   4. Identification: Identify cable on both ends.

C. Control Panels: Install subcomponents securely in panels or enclosures. Install as shown on Drawings.

D. Fiber Cable Terminations:
   1. In accordance with TIA 568-C.3.
   2. Fan out fiber cable to allow direct connectorization of connectors.
      a. Sleeve over individual fibers with transparent furcation tubes.
      b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
   3. Break-Out Kits:
      a. Terminate cables using manufacturer-supplied break-out kits.
      b. Terminate in accordance with manufacturer’s recommendations.
   4. Slack:
      a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
      b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
   5. Connectors:
      a. Terminate 100 percent fibers in each cable to specified connector.
      b. Connect into fiber management system.

E. Patch Cords:
   1. Install securely in panels per manufacturer’s instructions.
   2. Identify on both ends.

F. Conduit: Install in accordance with Section 26 05 33, Raceway and Boxes.

3.04 LABELING CONVENTIONS
A. Backbone Cables: Label in accordance with Section 26 05 02, Basic Electrical Requirements.
3.05 FIELD QUALITY CONTROL

A. General:

1. Advise Owner and Engineer at least 48 hours in advance of each test. Owner and Engineer shall have option to witness and participate actively in tests.
2. In accordance with Section 01 91 14, Equipment Testing and Facility Startup.
3. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
4. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
5. Testing performed on incomplete systems shall be redone on completion of the Work.
6. Document Test Results.

B. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Optical Fiber Cable Testers:
   a. Field test instrument shall be within calibration period recommended by manufacturer.
   b. Optical Loss Test Set (OLTS):
      1) Single-mode Optical Fiber Light Source:
         a) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
         b) Output Power: Minus 10 dBm, minimum.
         c) Manufacturer: Fluke Networks.
      2) Power Meter:
         a) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
         b) Power Measurement Uncertainty: Plus or minus 0.25 dB.
         c) Store reference power measurement.
         d) Save at least 100 results in internal memory.
         e) PC interface (serial or USB).
         f) Manufacturer: Fluke Networks.
      3) Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.
3. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
e. Serial and USB ports to transfer data to PC.
f. Single-Mode OTDR:
   1) Wavelengths: 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
   2) Event Dead Zone: 2 meters maximum at 1,310 nm and 2 meters maximum at 1,550 nm.
   3) Attenuation Dead Zone: 15 meters maximum at 1,310 nm and 15 meters maximum at 1,550 nm.
   4) Distance Range: Minimum 10,000 meters.
   5) Dynamic Range: Minimum 10 dB at 1,310 nm and 1,550 nm.
g. Manufacturer: Fluke Networks.

4. Fiber Microscope:
   a. Magnification: 250X or 400X for end-face inspection.
   b. Manufacturer: Fluke Networks.

5. Integrated OLTS, OTDR, and Fiber Microscope:
   a. Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.
   b. Manufacturer: Fluke Networks.

6. Complete Network System Testing:
   a. Able to complete automatic testing specified by RFC 2544 and RFC 6349.
   b. Manufacturer: Fluke Networks.

C. Fiber Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
   a. LIA Z136.2.
   b. TIA/EIA 455-78.
   c. TIA/EIA 455-133.
   d. TIA 526-7.
   e. TIA 526-14.
   f. TIA 568-C.1.
   g. TIA 568-C.3.
   h. TIA TSB 140.

2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

7. Document Tests:
   a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
   b. OTDR traces and event tables for single-mode and multimode links and channels.

D. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (Single-Mode and Multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

<table>
<thead>
<tr>
<th>Type of Optical Fiber</th>
<th>Wavelength (nm)</th>
<th>Attenuation Coefficient (dB/km)</th>
<th>Wavelength (nm)</th>
<th>Attenuation Coefficient (dB/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-mode (Inside plant)</td>
<td>1310</td>
<td>1.0</td>
<td>1550</td>
<td>1.0</td>
</tr>
<tr>
<td>Single-mode (Outside plant)</td>
<td>1310</td>
<td>0.5</td>
<td>1550</td>
<td>0.5</td>
</tr>
</tbody>
</table>

   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.
   c. Magnified Endface Inspection:
      1) Visually inspect fiber connections for end-face quality.
      2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

E. CAT6 Cable Testing:

1. Electrical performance as required for TIA-568-B including wiremap, cable length, insertion loss, near end crosstalk, power sum near end crosstalk, equal level far end crosstalk, power sum equal level far end crosstalk, return loss, propagation delay, and delay skew.
2. Physical installation shall be certified by the installer including location of cabling with respect to electrical noise and environmental conditions, grounding of devices, cable bending radii, cable supports, and terminations.

F. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

G. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Owner.

H. Fiber Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for subsequent uploading to a PC in which administrative documentation may be generated. Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.
   c. Perform Testing:
      1) On each cabling segment (connector to connector).
      2) On each cabling channel (equipment to equipment).
      3) Using high-quality test cords of same fiber type as cabling under test.
         a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
         b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):
   a. Backbone Link:
      1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.

3) Perform tests in both directions.

3. OTDR Testing:
   a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
      1) Single-mode: 1,310 nm and 1,550 nm.
      2) Multimode: 850 nm and 1,300 nm.
   b. Test each fiber link and channel in one direction.
   c. Install launch cable between OTDR and first link connection.
   d. Install receive cable after last link connection.

4. Magnified Endface Inspection:
   a. Inspect fibers at 250X or 400X magnification.
      1) 250X magnification is suitable for inspecting multimode and single-mode fibers.
      2) 400X magnification may be used for detailed examination of single-mode fibers.

5. Length Measurement:
   a. Record length of each fiber.
   b. Measure optical length using OLTS or OTDR.

6. Polarity Testing:
   a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
   b. Verify polarity of paired duplex fibers using OLTS.

7. Test Results Documentation:
   a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
   b. Available for inspection by Owner or Owner’s representative during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.
   c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Owner acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.
   d. Circuit IDs reported by test instrument shall match specified label identification.
e. Provide in electronic database for each tested optical fiber with the following information:
   1) Identification of Site.
   2) Name of test limit selected to execute stored test results.
   3) Name of personnel performing test.
   4) Date and time test results were saved in memory of tester.
   5) Manufacturer, model, and serial number of field test instrument.
   6) Version of test software and version of test limit database held within test instrument.
   7) Fiber identification number.
   8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
   9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
  10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
  11) Length for each optical fiber as calculated by the OTDR.
  12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.
  13) Magnified Endface Inspection:
      a) Picture or image of each fiber end-face.
      b) Pass/fail status of end-face based upon visual inspection.

I. Communication Systems Functional Test (CSFT):

1. Upon completion of cable and component installation and testing, and upon acceptance of cable and component testing submittals, the entire Network Communication System including the facility wireless communication system shall be tested as a functional system.

2. Notify Owner and Engineer in writing at least 10 days prior to scheduled date of testing.

3. Test Execution:
   a. Confirm network can operate under load over a time duration using automatic testing equipment.
   b. Testing shall conform to RFC 2544 and RFC 6349.
      1) Throughput.
      2) Burst.
      3) Frame loss.
      4) Latency.
J. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.
   a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.
   b. CAD drawings are to incorporate test data imported from test instruments.

2. As-Built Drawings:
   a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
   b. Include field changes made up to construction completion:
      1) Field directed changes to pull schedule.
      2) Field directed changes to cross connect and patching schedule.
      3) Horizontal cable routing changes.
      4) Backbone cable routing or location changes.
      5) Associated detail drawings.

END OF SECTION
PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. AB 1, Molded Case Circuit Breakers and Molded Case Switches.
   c. ICS 2, Industrial Control Devices, Controllers and Assemblies.

1.02 SYSTEM DESCRIPTION

A. Assemble panels and install instruments, plumbing, and wiring in equipment manufacturer’s factories.

B. Test panels and panel assemblies for proper operation prior to shipment from equipment manufacturer’s factory.

1.03 SUBMITTALS

A. Action Submittals:

1. Bill of material, catalog information, descriptive literature, wiring diagrams, and Shop Drawings for components of control system.
2. Catalog information on electrical devices furnished with system.
3. Shop Drawings, catalog material, and dimensional layout drawings for control panels and enclosures.
4. Panel elementary diagrams of prewired panels. Include in diagrams control devices and auxiliary devices, for example, relays, alarms, fuses, lights, fans, and heaters.
5. Submit electronic copies of Drawings in current AutoCAD version.
6. Plumbing diagrams of preplumbed panels and interconnecting plumbing diagrams.
7. Interconnection wiring diagrams that include numbered terminal designations showing external interfaces.
8. Component data sheets similar to ISA standard S20 forms.
10. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Programmable Controller Submittals:
   a. Contact information for attendance at Application Software Development Workshop. Submit telephone numbers and e-mail addresses for individuals participating in workshop.
   b. Complete set of user manuals.
   c. Fully documented ladder logic listings.
   d. Function listing for function blocks not fully documented by ladder logic listings.
   e. Cross-reference listing.
   f. PLC network communication data exchange documentation.
   g. Submit electronic copy of test ready PLC program 45 days prior to factory demonstration test.
   h. Submit electronic copy of PLC program including edits as a result of factory demonstration test 15 days prior to shipping to Site.
   i. Submit final electronic copy of PLC program including edits as a result of onsite testing and startup.

3. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.
         b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
      3) Test Documentation: Copy of signed off test results.
   b. Functional Test Part 1 and Part 2:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
3) Test Documentation:
   a) Copy of signed-off test results.
   b) Completed component calibration sheets.

   c. Performance Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results.

4. Manufacturer’s list of proposed spares, expendables, and test equipment.

5. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

1.04 APPLICATION SOFTWARE DEVELOPMENT WORKSHOPS

A. Where PLCs are used, attend an application software development workshop to ensure conformance with project-wide application software standards. The workshop will be held as a teleconference and/or live meeting. Workshop shall be split into two separate sessions of up to 4 hours each.

B. Purpose: Coordinate with Contractor, Owner and Software Integrator to ensure software controls interface requirements are understood and necessary information is exchanged. Workshop to be held 30 days prior to manufacturer software development.

C. Workshop Topics:
   1. Review of Process Control Narratives relating to the package control system, interfaces with equipment supplied by the Contractor and software supplied by the Software Integrator.
   2. Review of specific control functions provided by the package control system.
   3. Control functions available from the Plant Control System (PCS).
   4. Network address assignments.
   5. PLC functionality including conventions for status and alarms, LOCAL/REMOTE and AUTO/MANUAL control modes.
   6. PLC to PLC communication approach, communication monitoring and alarms.

D. Required Attendance:
   1. Provide for workshop attendance by telephone and live meeting for the following individuals:
      a. Manufacturer’s PLC software programmer responsible for project PLC application software.
b. Manufacturer’s Project Manager.
c. Software Integrator.
d. Contractor.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive-inhibitive vapor capsules in shipping containers and related equipment as recommended by capsule manufacturer.

1.06 EXTRA MATERIALS

A. Spares, Expendables, and Test Equipment:
   1. Selector Switch, Pushbutton, and Indicating Light: 20 percent, one minimum, of each type used.
   2. Light Bulb: 100 percent, two minimum of each type used.
   3. Fuse: 100 percent, five minimum of each type used.
   4. Surge Suppressors: 20 percent, one minimum of each type used.

PART 2 PRODUCTS

2.01 GENERAL

A. Section 40 90 00, Instrumentation and Control for Process Systems.
B. Section 40 91 00, Instrumentation and Control Components.

2.02 SIGNAL CHARACTERISTICS

A. Analog Signals:
   1. 4 mA dc to 20 mA dc, in accordance with compatibility requirements of ISA S50.1.
   2. Unless otherwise specified or shown, use Type 2, two-wire circuits.
   3. Transmitters: Load resistance capability conforming to Class L.
   4. Fully isolate input and output signals of transmitters and receivers.

B. Pulse Frequency Signals: dc pulses whose repetition rate is linearly proportional to process variable over 10:1 range. Generate pulses by contact closures or solid-state switches.
   1. Power Source: Less than 30V dc.

C. Discrete Signals:
   1. Two-state logic signals.
   2. Utilize 120V ac sources for control and alarm signals.
3. Alarm signals shall be normally closed, open to alarm isolated contacts rated for 5-ampere at 120V ac and 2-ampere at 30V dc.

2.03 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsule Manufacturers:
   1. Northern Instruments; Model Zerust VC.
   2. Hoffmann Engineering; Model A-HCI.

2.04 CONTROL PANEL

A. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), UL 508, state and local codes, and applicable sections of NEMA, ANSI, and ICECA.

B. Conform to NEMA ratings as specified in individual equipment sections.

C. Minimum Metal Thickness: 14-gauge.

D. NEMA 250, Type 4X Panels: Type 316 stainless steel construction unless otherwise specified.

E. Doors:
   1. Three-point latching mechanisms in accordance with NEMA 250 Type 1 and Type 12 panels with doors higher than 18 inches.
   2. For other doors, stainless steel quick release clamps.

F. Cutouts shall be cut, punched, or drilled and finished smoothly with rounded edges.

G. Access: Front, suitable for installation with back and sides adjacent to or in contact with other surfaces, unless otherwise specified.

H. Temperature Control:
   1. Size panels to adequately dissipate heat generated by equipment mounted on or in the panel.
   2. Furnish cooling fans with air filters if required to dissipate heat.
   3. For panels outdoors or in unheated areas, furnish thermostatically controlled heaters to maintain temperature above 40 degrees F.

I. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
PHASE IV BEAVER CREEK WATER SUPPLY

J. Lighting: Minimum of one hand switch controlled internal fluorescent or LED light for panels 12 cubic feet and larger.

K. Minimum of one 120-volt GFCI duplex receptacle for panels 12 cubic feet and larger.

L. Finish:
   1. Metallic External Surfaces (Excluding Aluminum and Stainless Steel): Manufacturer’s standard gray unless otherwise specified.
   2. Internal Surfaces: White enamel.

M. Panel Manufacturers:
   1. Hoffman.
   2. H.F. Cox.

N. Breather and Drains: Furnish with NEMA 250, Type 4 and Type 4X panels.
   1. Manufacturer and Products: Cooper Crouse-Hinds; ECD Type 4X Drain and Breather; Drain Model ECD1-N4D, Breather Model ECD1-N4B.

2.05 CONTROL PANEL ELECTRICAL

A. UL Listing Mark for Enclosures: Mark stating “Listed Enclosed Industrial Control Panel” per UL 508A.

B. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

C. Control Panels with Programmable Logic Controllers or network communication components shall have two external 120V ac circuits feeding the panel provided by Division 26, Electrical. Standard 120V ac circuit shall feed utility receptacle, light, and noncritical loads. 120V ac uninterruptible power supply circuit shall feed PLCs, network communication components and other critical loads.

D. Control Panels without Motor Starters:
   1. Furnish main circuit breaker and a circuit breaker on each individual branch circuit distributed from power panel.
   2. Locate to provide clear view of and access to breakers when door is open. Group on single subpanel. Provide typed directory.
   3. Circuit Breakers:
      a. Coordinate for fault in branch circuit trips, branch breaker, and not main breaker.
b. Branch Circuit Breakers: 15 amps at 250V ac.
c. Breaker Manufacturers and Products:
   1) Heineman Electric Co.; Series AM.
   2) Airpax/North American Philips Controls Corp.; Series 205.

E. Control Panels with Three-Phase Power Supplies and Motor Starters:

1. All circuits greater than 120V ac shall be located in a separate compartment or enclosure from control circuits below 120V ac, with separate access in order to minimize the NFPA 70E arc flash hazard/risk category of the controls portion of the enclosure.

2. Interlock main circuit breaker with panel door.
   a. Mount logic controls, branch circuit breakers, overload reset switches, and other control circuit devices.
   b. Mount operator controls and indications on front access door.

3. Circuit Breakers:
   a. In accordance with NEMA AB 1.
   b. 18,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified.
   c. Breakers, except Motor Branch Breakers: Molded case thermal magnetic.
   d. 42,000-ampere RMS symmetrical rating, minimum at 480 volts, unless otherwise specified in package system equipment specification sections.
   e. Tripping: Indicate with operator handle position.

4. Magnetic Motor Starters:
   a. Full voltage, NEMA ICS 2, Class A, Size O minimum.
   b. Include three-pole bimetallic or eutectic alloy thermal overload relays sized for each motor.
   c. Manual reset type with reset button mounted on panel door.

5. Motor Control: 120V ac (except intrinsically safe circuits where applicable).
   a. Power Control Transformer:
      1) Sufficient capacity to serve connected load, including 200VA for duplex outlet plus 100VA (minimum).
      2) Limit voltage variation to 15 percent during contact pickup.
      3) Fuse one side of secondary winding and ground the other.
      4) Furnish primary winding fuses in ungrounded conductors.

6. Power Monitoring Relay:
   a. Protect three-phase equipment from single-phasing, phase imbalance, or phase reversal.
   b. Separate, isolated contact outputs to stop motors and activate alarm light during abnormal conditions.
   c. Transient Voltage Protection: 10,000 volts.
   d. Manufacturer and Product: Furnas; Class 47.

8. Terminations for Power Conductors: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

F. Wiring:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than 14 AWG.

2. Analog Signal Circuits:
   a. Type: 300-volt, Type 2 stranded copper, twisted shielded pairs.
   b. Size: 18 AWG, minimum.

3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: 18 AWG, minimum.

4. Separate analog and other dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.

5. Enclose wiring in sheet metal raceways or plastic wiring ducts.

6. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.
   b. Manufacturers:
      1) Brady PermaSleeve.
      2) Tyco Electronics.

G. Wiring Interface:

1. For analog and discrete signal, terminate at numbered terminal blocks.

2. For special signals, terminate power (240 volts or greater) at manufacturer’s standard connectors.

3. For panel, terminate at equipment on/with which it is mounted.

H. Terminal Blocks:

1. Quantity:
   a. For external connections.
   b. Wire spare or unused panel mounted elements to their panels’ terminal blocks.
   c. Spare Terminals: 20 percent of connected terminals, but not less than 10.

2. General: Group to keep 120V ac circuits separate from 24V dc circuits.
   a. Connection Type: Screw connection clamp.
b. Compression Clamp:
   1) Hardened steel clamp with transversal grooves penetrating wire strands providing a vibration-proof connection.
   2) Guides strands of wire into terminal.
d. Current Bar: Copper or treated brass.
e. Insulation:
   1) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
   2) Two funnel shaped inputs to facilitate wire entry.
f. Mounting:
   1) Rail.
   2) Terminal block can be extracted from an assembly without displacing adjacent blocks.
   3) End Stops: One at each end of rail, minimum.
g. Wire Preparation: Stripping only.
h. Jumpers: Allow jumper installation without loss of space on terminal or rail.
i. Marking System:
   1) Terminal number shown on both sides of terminal block.
   2) Allow use of preprinted and field marked tags.
   3) Terminal strip numbers shown on end stops.
   4) Mark terminal block and terminal strip numbers as shown.

3. Terminal Block, 120-Volt Power:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 30-amp.
   c. Wire Size: 22 AWG through 10 AWG.
   d. Rated Wire Size: 10 AWG.
   e. Color: Gray body.
   f. Spacing: 0.25 inch, maximum.
   g. Manufacturer and Product: Entrelec; Type M4/6.

4. Terminal Block, Ground:
   a. Wire Size: 22 AWG through 12 AWG.
   b. Rated Wire Size: 12 AWG.
   c. Color: Green and yellow body.
   d. Spacing: 0.25 inch, maximum.
   e. Grounding: Ground terminal blocks electrically grounded to the mounting rail.
   f. Manufacturer and Product: Entrelec; Type M4/6.P.

5. Terminal Block, Blade Disconnect Switch:
   a. Use: Provide one for each discrete input and output field interface wire.
   b. Rated Voltage: 600V ac.
   c. Rated Current: 10-amp.
   d. Wire Size: 22 AWG through 12 AWG.
e. Rated Wire Size: 12 AWG.

f. Color: Gray body, orange switch.

g. Spacing: 0.25 inch, maximum.

h. Manufacturer and Product: Entrelec; Type M4/6.SN.

6. Terminal Block, Fused, 24V dc:
   a. Rated Voltage: 600V dc.
   b. Rated Current: 6.3-amp.
   c. Wire Size: 22 AWG through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 GMA by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: LED diode 24V dc.
   i. Leakage Current: 5.2 mA, maximum.
   j. Spacing: 0.32 inch, maximum.
   k. Manufacturer and Product: Entrelec; Type M4/6.SFD.

7. Terminal Block, Fused, 120V ac:
   a. Rated Voltage: 600V ac.
   b. Rated Current: 6.3-amp.
   c. Wire Size: 22 AWG through 12 AWG.
   d. Rated Wire Size: 12 AWG.
   e. Color: Gray body.
   f. Fuse: 5 GMA by 20 GMA fuses.
   g. Fuse Marking: Fuse amperage rating shown on top of terminal block.
   h. Indication: Neon lamp 110V ac.
   i. Leakage Current: 1.8 mA, maximum.
   j. Spacing: 0.32 inch, maximum.
   k. Manufacturer and Product: Entrelec; Type M4/6.SFL.

I. Grounding: Internal copper grounding bus for ground connections on panels, consoles, racks, and cabinets.

J. Relays:

1. General:
   b. Relay Enclosure: Provide dust cover.
   c. Socket Type: Screw terminal interface with wiring.
   d. Socket Mounting: Rail.
   e. Furnish holddown clips.

2. Control Circuit Switching Relay, Nonlatching:
   a. Type: Compact general purpose plug-in.
   b. Contact Arrangement: 3 Form C contacts.
c. Contact Rating: 10A at 28V dc or 240V ac.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As noted or shown.
f. Coil Power: 1.8 watts (dc), 2.7VA (ac).
g. Expected Mechanical Life: 10,000,000 operations.
h. Expected Electrical Life at Rated Load: 100,000 operations.
i. Indication Type: Neon or LED indicator lamp.
j. Push-to-test button.
k. Manufacturers and Products:
   1) Potter and Brumfield; Series KUP.
   2) Allen-Bradley.

3. Control Circuit Switching Relay, Latching:
a. Type: Dual coil mechanical latching relay.
b. Contact Arrangement: 2 Form C contacts.
c. Contact Rating: 10A at 28V dc or 120V ac.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As noted or shown.
f. Coil Power: 2.7 watts (dc), 5.3VA (ac).
g. Expected Mechanical Life: 500,000 operations.
h. Expected Electrical Life at Rated Load: 50,000 operations.
i. Manufacturers and Products:
   1) Potter and Brumfield; Series KB/KBP.
   2) Allen-Bradley.

4. Control Circuit Switching Relay, Time Delay:
a. Type: Adjustable time delay relay.
b. Contact Arrangement: 2 Form C contacts.
c. Contact Rating: 10A at 240V ac.
d. Contact Material: Silver cadmium oxide alloy.
e. Coil Voltage: As specified or shown.
f. Operating Temperature: Minus 10 degrees C to 55 degrees C.
g. Repeatability: Plus or minus 2 percent.
h. Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent or range.
i. Time Delay Setpoint: As specified or shown.
j. Mode of Operation: As specified or shown.
k. Adjustment Type: Integral potentiometer with knob external to dust cover.
l. Manufacturers and Products:
   1) Potter and Brumfield.
      a) Series CB for 0.1-second to 100-minute delay time ranges.
      b) Series CK for 0.1- to 120-second delay time ranges.
   2) Allen-Bradley.
K. Intrinsic Safety Barriers:
   1. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
   2. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.

L. Programmable Controllers:
   1. Solid state units capable of performing same function as conventional relays, timers, counters, drum sequencers, arithmetic, and other special functions necessary to perform required control functions.
   2. Minimum of 64 internal control relays, 16 timer/counters, and four, 16 stop drum sequencers. Furnish minimum of 256 words of nonvolatile memory.
   3. Minimum of 12 discrete inputs and 8 discrete outputs, optical isolations rated at 2,500-volt rms. Discrete inputs shall be 120V ac. Discrete outputs shall be rated for 2 amps at 120V ac. Each input and output shall have an LED ON/OFF status indicator.
   4. Minimum of 25 percent excess capacity for inputs, outputs, internal coils, registers, and other necessary functions.
   5. Capable of operating in a hostile industrial environment (for example, heat, electrical transients, RFI, and vibration) without fans, air conditioning, or electrical filtering. Units operate from 0 degrees C to 60 degrees C and up to 95 percent humidity, noncondensing.
   6. Manufacturer and Product: Allen-Bradley; Compactlogix, firmware Version 31 or later.

M. Front-of-Panel Devices in Conjunction with NEMA 250, Type 1 and Type 12 Panels:
   1. Potentiometer Units:
      a. Three-terminal, oiltight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
      b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 inch and 1/4 inch.
      c. Include legend plates with service markings.
      d. Manufacturers and Products:
         1) Allen-Bradley; Model 800T.
         2) Eaton/Cutler-Hammer; Model 10250T.
   2. Indicating Lights:
      a. Heavy-duty, push-to-test type, oiltight, industrial type with integral transformer for 120V ac applications.
b. Screwed on prismatic glass lenses in colors noted and factory engraved legend plates for service legend.
c. Manufacturers and Products:
   1) Allen-Bradley.
   2) Eaton/Cutler-Hammer; Type 10250T.
   3) General Electric; CR2940U.

3. Pushbutton, Momentary:
   a. Heavy-duty, oiltight, industrial type with full guard and momentary contacts rated for 10 amperes continuous at 120V ac.
   b. Standard size legend plates with black field and white markings for service legend.
   c. Manufacturers and Products:
      1) Allen-Bradley.
      2) Square D; Class 9001, Type K.
      3) Eaton/Cutler-Hammer; Type T.
      4) General Electric; Type CR-2940.

4. Selector Switch:
   a. Heavy-duty, oiltight, industrial type with contacts rated for 120V ac service at 10 amperes continuous.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 inch to 1/4 inch.
   e. Manufacturers and Products for Units with up to Four Selection Positions:
      1) Allen-Bradley.
      2) Eaton/Cutler-Hammer; Type T.
      3) Square D; Type K.
   f. Manufacturers and Products for Units with up to 12 Selection Positions:
      1) Rundel-Idec; Standard Cam Switch.
      2) Electroswitch; 31.

N. Front-of-Panel Devices Used in Conjunction with NEMA 250, Type 4X Panels:

1. Potentiometer, Watertight:
   a. Three-terminal, heavy-duty NEMA 250, Type 4X watertight construction, resolution of 1 percent and linearity of plus or minus 5 percent.
   b. Single-hole, panel mounting accommodating panel thicknesses between 1/8 inch and 1/4 inch.
   c. Include engraved legend plates with service markings.
   d. Manufacturer and Product: Allen-Bradley; Bulletin 800H.
2. Indicating Lights, Watertight:
   a. Heavy-duty, push-to-test type, NEMA 250, Type 4X watertight, industrial type with integral transformer for 120V ac applications and corrosion-resistant service.
   b. Screwsed on prismatic lenses and factory engraved legend plates for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.

3. Pushbutton, Momentary, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with momentary contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings for service legend.
   c. Manufacturers and Products:
      1) Square D; Type SK.
      2) Allen-Bradley; Type 800H.

4. Selector Switch, Watertight:
   a. Heavy-duty, NEMA 250, Type 4X watertight, industrial type with contacts rated for 120V ac service at 10 amperes continuous and corrosion-resistant service.
   b. Standard size, black field, legend plates with white markings, for service legend.
   c. Operators: Black knob type.
   d. Single-hole mounting, accommodating panel thicknesses from 1/16 to 1/4 inch.
   e. Manufacturers and Products:
      1) Square D; Class 9001, Type SK.
      2) Allen-Bradley; Type 800H.

O. Industrial Network Switch:

1. General:
   a. UL 508 safety rating.
   b. Up to 16 port connections.
   c. Serial configuration port.
   d. Configurable alarm contact.
   e. Provide ports for each switch application as shown on Drawings.

2. Features:
   a. Fully Managed:
      1) SNMP v1, v2, v3.
      2) Web browser management.
      3) Detailed ring map and fault location charting.
      4) Ethernet Ring with a maximum of 30 ms healing time.
5) IGMP auto-configuration.
6) VLAN management.
7) RSTP.
8) IGMP.
9) DHCP.
10) Trunking and port mirroring.
11) N-Ring technology with 30 ms healing.
12) Ethernet/IP CIP Messaging:
    a) VLAN supporting IEEE 802.1Q.
       (1) Port rate limiting.
13) Broadcast storm filtering.
14) Command line interface.

3. Ports:
   a. Ethernet: 10/100TX RJ45 connectors.
   b. Auto sensing.


5. Power Inputs: Two.

6. Certification: UL.

7. Mean Time Between Failures: 1 million hours.

8. Environmental:
   a. Operating Temperature: Minus 20 degrees C to 60 degrees C.
   b. Operating Humidity: 5 percent to 95 percent (noncondensing).

9. Power Supply:
   a. 24V dc.

10. Manufacturer and Product: N-Tron; 708TX (8-port) or 716TX (16-port).

2.06 INSTRUMENT TAG NUMBERS

A. As shown on Drawings.

2.07 NAMEPLATES, NAMETAGS, AND SERVICE LEGENDS

A. Nametags: Permanently mounted bearing entire ISA tag number.
   1. Panel Mounted: Plastic, mounted to instrument behind panel face.
   2. Field Mounted: Engraved Type 316 stainless steel, 22-gauge minimum thickness, attached with stainless steel.

B. Service Legends (Integrally Mounted with Instrument) and Nameplates:
   1. Engraved, rigid, laminated plastic type with adhesive back. Furnish service legends and nameplates to adequately describe functions of panel face mounted instruments.
   2. Color: White with black letters.
   3. Letter Height: 3/16 inch.
4. For each panel, face mounted laminated nameplate inscribed with the panel name and tag number. Color shall be white with black letters 1/2 inch high.

C. Standard Light Colors and Inscriptions: Unless otherwise specified in individual equipment specifications, use the following color code and inscriptions:

<table>
<thead>
<tr>
<th>Tag</th>
<th>Inscription(s)</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
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<td>Green</td>
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<tr>
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</tr>
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</table>

1. Lettering: Black on white and amber lenses; white on red and green lenses.
2. Standard Pushbutton Colors and Inscriptions:
   a. Use the following:

<table>
<thead>
<tr>
<th>Tag Function</th>
<th>Inscription(s)</th>
<th>Color</th>
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<tbody>
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</tr>
<tr>
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<td>OPEN, CLOSE, AUTO</td>
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### 2.08 ELECTRICAL SURGE AND TRANSIENT PROTECTION

**A.** Equip control panels with surge-arresting devices to protect equipment from damage as a result of electrical transients induced in interconnecting lines from lightning discharges and nearby electrical devices.

**B.** Suppressor Locations:

1. At point of connection between an equipment item, including ac powered transmitters, and power supply conductor (direct-wired equipment).
2. On analog pairs at each end when the pair travels outside of building.
3. In other locations where equipment sensitivity to surges and transients requires additional protection beyond that inherent to design of equipment.

**C.** Suppressor Design:

1. Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2. Response: 5 nanoseconds maximum.
4. Temperature Range: Minus 20 degrees C to plus 85 degrees C.
5. Enclosure Mounted: Encapsulated inflame retardant epoxy.

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#### Tag Function, Inscription(s), Color

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</table>

b. Lettering Color:

1) Black on white and yellow buttons.
2) White on black, red, and green buttons.
D. Suppressors on 120V ac Power Supply Connections:

1. Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
2. First-stage Clamping Voltage: 350 volts or less.
3. Second-stage Clamping Voltage: 210 volts or less.
4. Power Supplies for Continuous Operation:
   a. Four-Wire Transmitter or Receiver: Minimum 5 amps at 130V ac.
   b. All Other Applications: Minimum 30 amps at 130V ac.

E. Suppressors on Analog Signal Lines:

1. Test Waveform: Linear 8-microsecond rise in current from 0 amp to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
2. Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
   a. dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
   b. dc Clamping Voltage Tolerance: Plus or minus 10 percent.
   c. Maximum Loop Resistance: 18 ohms per conductor.

F. Manufacturers and Products:

1. Analog Signals Lines: Emerson Edco; PC-642 or SRA-64 series.
2. 120V ac Lines: Emerson Edco; HSP-121.
3. 480-Volt, Three-phase Power Supplies: Square D; Model SDSA3650.
4. Field Mounted at Two-wire Instruments:
   a. Encapsulated in stainless steel pipe nipples.
   b. Emerson Edco; SS64 series.
5. Field Mounted at Four-Wire Instruments: With 120V ac outlet, ac circuit breaker, and 10-ohm resistor on signal line, all in enclosure.
   a. Enclosure:
      1) NEMA 4X Type 316 stainless steel with door.
      2) Maximum Size: 12 inches by 12 inches by 8 inches deep.
   b. Emerson Edco; SLAC series.

G. Grounding:

1. Coordinate surge suppressor grounding in field panels and field instrumentation as specified in Section 26.05.26, Grounding and Bonding for Electrical Systems, and suppressor manufacturer’s requirements.
2. Provide control panels with an integral copper grounding bus for connection of suppressors and other required instrumentation.
SOURCE QUALITY CONTROL

A. General:

1. Engineer may actively participate in many of the tests.
2. Engineer reserves right to test or retest specified functions.
3. Engineer’s decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
   a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Engineer accepted procedures, forms, and checklists.
   b. Describe each test item to be performed.
   c. Have space after each test item description for sign off by appropriate party after satisfactory completion.
5. Required Test Documentation: Test procedures, forms, and checklists signed by Engineer and Contractor.
6. Conducting Tests:
   a. Provide special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
   d. Define simulation techniques in test procedures.
   e. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test controls to ensure it is operational, ready for FDT.
2. Location: Manufacturer’s facility.
3. Integrated Test:
   a. Interconnect and test package control system, except for primary elements and smaller panels.
   b. Exercise and test functions.
   c. Provide stand-alone testing of smaller panels.
   d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.
C. Factory Demonstration Tests (FDT):

1. Notify Engineer of test schedule 4 weeks prior to start of test.
2. Scope: Test entire package control system including interfaces with the PCS, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
3. Location: Manufacturers facility.
4. Coordinate PCS interface tests with Software Integrator.
5. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
   a. Simulate each discrete signal at terminal strip.
   b. Simulate correctness of each analog signal using current source.
6. Operation of communications between PLCs and remote I/O and between PLCs and computers.
7. Failed Tests: Repeat and witnessed by Engineer.
8. Make following documentation available to Engineer at test site during FDT:
   b. Master copy of FDT procedures.
   c. List of equipment to be tested including make, model, and serial number.
   d. Approved hardware Shop Drawings for equipment being tested.
   e. Approved preliminary software documentation Submittal.
9. Daily Schedule for FDT:
   a. Begin each day with meeting to review day’s test schedule.
   b. End each day with each meeting to review day’s test results and to review or revise next day’s test schedule.

PART 3   EXECUTION

3.01 ELECTRICAL POWER AND SIGNAL WIRING

A. Restrain control and signal wiring in control panels by plastic ties or ducts. Secure hinge wiring at each end so bending or twisting will occur around the longitudinal axis of wire. Protect bend area with a sleeve.

B. Arrange wiring neatly, cut to proper length, and remove surplus wire. Install abrasion protection for wire bundles passing through holes or across edges of sheet metal.

C. Use manufacturer’s recommended tool with sized anvil for crimp terminations. No more than one wire may be terminated in a single crimp lug. No more than two lugs may be installed on a single screw terminal.

D. Do not splice or tap wiring except at device terminals or terminal blocks.
3.02 PROTECTION

A. Protect enclosures and other equipment containing electrical, instrumentation and control devices, including spare parts, from corrosion through the use of corrosion-inhibiting vapor capsules.

B. During Work, periodically replace capsules in accordance with capsule manufacturer’s recommendations. Replace capsules at Substantial Completion.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate testing with Owner and affected Subcontractors.
2. Notify Engineer of test schedule 4 weeks prior to start of test.
3. Engineer may actively participate in tests.
4. Engineer reserves right to test or retest specified functions.
5. Engineer’s decision will be final regarding acceptability and completeness of testing.

B. Testing Sequence:

1. Provide Functional Tests, Performance Tests, Clean Water Tests and Facility Performance Demonstration for facilities as required to support staged construction and startup of plant.
2. Refer to Article Sequence of Work under Section 01 31 13, Project Coordination, for a definition of Project milestones.
3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for overall testing requirements.
4. Refer to Section 40 90 00, Instrumentation and Control for Process Systems, for coordination of tests with PIC System Integrator.
5. Completion: When tests (except Functional Test) have been completed and required test documentation has been accepted.

C. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated equipment is ready for operation. Divide Functional Test for each facility into two parts.
2. Software Integrator Factory Software Acceptance Test (FSAT):
   a. Purpose: Performed by Software Integrator to test the integration of the package control systems with the plant wide control system, with exception of primary elements, final control elements, and certain smaller panels.
b. Package System Vendor Role: Provide documented electronic
copies of approved PLC programs following FDT to Software
Integrator for use in FSAT.

c. Location: Software Integrator facility.

3. FT1: Performed by PIC System Integrator, Contractor and package
system vendors to test and document the package control system,
excluding vendor provided applications software, is ready for operation.

a. Loop/Component Inspections and Tests:
   1) These inspections and tests will be spot checked by
      Engineer.
   2) Check for proper installation, calibration, and adjustment on
      loop-by-loop and component-by-component basis.
   3) Provide space on forms for signoff by vendor.
   4) Use loop status report to organize and track inspection,
      adjustment, and calibration of each loop and include the
      following:
      a) Project name.
      b) Loop number.
      c) Tag number for each component.
      d) Checkoffs/Signoffs for Each Component:
         (1) Tag/identification.
         (2) Installation.
         (3) Termination wiring.
         (4) Termination tubing.
         (5) Calibration/adjustment.
      e) Checkoffs/Signoffs for the Loop:
         (1) Panel interface terminations.
         (2) I/O interface terminations with PLCs.
      f) I/O Signals for PLCs are Operational: Received/sent,
         processed, adjusted.
      g) Total loop operational.
      h) Space for comments.

5) Component calibration sheet for each active I&C
component (except simple hand switches, lights, gauges,
and similar items) and each PLC I/O module and include the
following:
   a) Project name.
   b) Loop number.
   c) Component tag number or I/O module number.
   d) Component code number for I&C elements.
   e) Manufacturer for I&C elements.
   f) Model number/serial number for I&C elements.
g) Summary of functional requirements; for example:
   (1) Indicators and recorders, scale and chart ranges.
   (2) Transmitters/converters, input and output ranges.
   (3) Computing elements’ function.
   (4) Controllers, action (direct/reverse) and control modes (P, I, D).
   (5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
   (6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
   (1) Analog Devices: Actual inputs and outputs at 0 percent, 10 percent, 50 percent, and 100 percent of span, rising and falling.
   (2) Discrete Devices: Actual trip points and reset points.
   (3) Controllers: Mode settings (P&ID).
   (4) I/O Modules: Actual inputs or outputs of 0 percent, 10 percent, 50 percent, and 100 percent of span, rising and falling.
   (5) Space for comments.

b. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.

c. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.

d. FDT-Repeat:
   1) Repeat FDT onsite with installed equipment and software.
   2) Use FDT test procedures as basis for this test.
   3) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.

4. FT2: Combined effort between Contractor, PIC System Integrator, package system vendor, and Software Integrator to confirm system, including applications software, and PCS software is ready for operation.
   a. Prerequisite:
      1) Completion of Functional Test Part 1.
      2) Completion of Communication System Functional Test as described in Section 40 95 80, Network Communication Systems.
b. Joint test with Software Integrator. Repeat of SSDT application software tests, except using real field sensors and equipment. Plant interlocking and communications with PLCs, FOCS, and HMI tested on loop-by-loop basis.

c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

D. Performance Test (PT) During and After Facility Startup:

1. Once a facility’s Functional Tests have been completed and that facility has been started up, perform jointly with Engineer and Software Integrator Performance Test on associated vendor equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.

2. Loop-specific and nonloop-specific tests same as required for FDT that entire installed vendor system tested using actual process variables and functions demonstrated.

3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.

4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.

5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.

6. Make O&M data available to Engineer at Site both before and during testing.

END OF SECTION
SECTION 43 40 02
FIBERGLASS REINFORCED PLASTIC TANK

EQUIPMENT AND COMPONENT NUMBER(S)

The fiberglass reinforced plastic tanks specified herein and listed below are in the sodium hypochlorite generation system manufacturer’s scope of supply. Refer to Section 44 44 13.02, Sodium Hypochlorite Generation System.

Brine Saturator Tank: P20T0113.
Sodium Hypochlorite Tank: P20T0117.

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

1.  American Society of Mechanical Engineers (ASME):
   b.  RTP-1, Reinforced Thermoset Plastic Corrosion Resistant Equipment.

2.  ASTM International (ASTM):


1.02  DEFINITIONS

A.  FRP: Fiberglass reinforced plastic.
1.03 DESIGN REQUIREMENTS

A. Design Loads: In accordance with Section 01 61 00, Common Product Requirements.

B. Tanks specified to be fabricated to ASME RTP-1 requirements shall be designed, fabricated, and code stamped. ASME RTP-1 shall be all inclusive for tanks so specified.

C. Design tank, including resin selection (unless specified), wall thickness, methods and locations of support, and stiffener requirements. Design shall be prepared and sealed by designer meeting requirements of Article Quality Assurance.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fabricators catalog information, descriptive literature, specifications, and identification of materials of construction, including complete resin system information.
   b. Letter from resin manufacturer stating that selected resin is suitable for intended service.
   c. Detailed fabrication drawings.
   d. Tank data indicating equipment number, pressure rating, diameter, straight shell lengths, overall lengths, wall thickness, corrosion barrier thickness, and details of nozzle designs.
   e. Tank capacity chart indicating gallons for each foot of depth and cumulative total from bottom.
   f. Fabricator’s detailed requirements for tank foundations.
   g. Recommended bolt torque for bolted FRP connections.
   h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing. Drawings shall show all data and details required for design of the tank equipment pads including locations and dimensions for knockouts and embedded items, and the size, type, location, embedment and projection of anchor bolts.

2. Samples: Laminate sample representative of production quality of surface finish and visual imperfections.

B. Informational Submittals:

1. Complete design calculations for tanks, supports and appropriate accessories.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Certification to ASME RTP-1.
4. Fabricator’s Certificate of Compliance with fabrication requirements.
5. Qualifications of Fabricator’s Quality Assurance Supervisor.
6. Copy of fabricator’s Quality Assurance Program.
7. Quality Assurance Inspection:
   b. Initial QA Inspection Report.
8. Special shipping, storage and protection, and handling instructions.
9. Fabricator’s printed installation and tank support instructions.
10. Manufacturer’s Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturers’ Field Services.

C. Contract Closeout Submittals: Service records for repairs performed during construction.

1.05 QUALITY ASSURANCE

A. Fabricator’s Quality Assurance Supervisor: Minimum of 5 years’ experience in fabrication of fiberglass structures.

B. Designer: Registered professional engineer licensed in state where Project is located.

1.06 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 61 00, Common Product Requirements. In addition, prepare and protect tank for shipment as follows:

   1. Mount tank on padded cradles if shipped horizontally or on a suitable skid if shipped vertically.
   2. Protect flanged nozzles with wooden blinds bolted to flange and having a diameter of 2 inches greater than outside diameter of flange.
   3. Provide either rigid plugs inside ends to prevent deflection or wooden boxes for unflanged components. Brace open end of tank with suitable stiffening member to prevent deflection.
   4. Do not ship components or other pieces loose inside tank.
   5. Load tank with at least 2 inches of clearance between tank (including fittings) and bulkheads, or bed of vehicle.
   6. Regardless of mode of transportation, firmly fasten and pad components to prevent shifting of load or flexing of components while in transit.
1.07 SEQUENCING AND SCHEDULING

A. Do not ship tank from factory until Engineer’s review of Certification of Factory Testing is completed.

PART 2 PRODUCTS

2.01 SUPPLEMENTS

A. Some specific requirements relative to this section are attached as supplements at the end of section.

2.02 SERVICE CONDITIONS

A. Operating Pressure: Atmospheric.

B. Location:

2. Sodium Hypochlorite Tank: Indoor

2.03 MATERIALS

A. Filament-Wound: Fabricate in accordance with ASTM D3299, Type I, Grade 1 and ASME RTP-1.

B. Resin:

1. Suitable for intended service.
2. Premium grade and corrosion resistant vinyl ester.
3. Use same resin throughout entire tank shell.
4. Add ultraviolet absorbers to surfacing resin to improve weather resistance.
5. No dyes, pigments, or colorants, except in exterior gel coat.
6. No fillers or thixotropic agents.
7. Curing System:
   a. As recommended by resin manufacturer or as specified herein.
   b. Cure products as specified in ASME RTP-1.
   c. Measure Barcol hardness according to ASTM D2583.
8. Post-cure tank and appurtenances in accordance with resin manufacturer’s recommendation for time and temperature. Post-curing should be completed with warm-to-hot dry air, free of combustion products. Hot spots shall be avoided.
9. For hypochlorite service, no MEKP cobalt catalyst system shall be allowed in liner. Cure liner with benzoyl peroxide-dimethyl aniline. Structural layer may be cured with either catalyst system.
C. Reinforcements:
   1. Surfacing Veil: Chemical surfacing mat, two layers of polyester fabric, 
      12 mils to 16 mils thick, with a finish and a binder compatible with the 
      lay-up resin. 
   2. Other Reinforcements: In accordance with ASME RTP-1.

D. Laminate:
   1. Consists of inner surface (corrosion barrier), interior layer, and exterior 
      layer (structural layer). 
   2. Meet visual acceptance criteria in ASME RTP-1. 
   3. Meet requirements of mechanical properties in ASME RTP-1. 
   4. Reinforce inner surface with resin-rich surfacing veil as specified 
      herein. 
   5. Apply a white color coat after inspection of laminate has been 
      completed.

E. Marking:
   1. Identify each tank with fabricator’s name, capacity in gallons, maximum 
      temperature, design pressure/vacuum, specific gravity, pH, resin, 
      minimum thickness, tank number, tank name, and date of manufacture. 
   2. Provide permanent marking. Seal decals, labels, etc., into laminate 
      exterior with clear resin.

F. Nozzles:
   1. Gusset 4-inch or smaller nozzles with conical or plate type gussets. 
      Larger nozzles shall be gusseted, if noted. 
   2. Finish flush with inside surface of tank, unless otherwise indicated. 
   3. Gaskets:
      a. Provide two per nozzle, 1/8-inch-thick, full-face elastomeric 
         material having a hardness of Shore A60 plus or minus 5. 
      b. Material shall be suitable for intended service. 
   4. Flanged Nozzles: Rated at 100 psi, with other dimensions and bolting 
      corresponding to ASME B16.5 for 150-pound steel flanges. 
   5. Back face of flanges shall be spot-faced, flat and parallel to flange face 
      of sufficient diameter to accept SAE metal washer under bolthead or 
      nut.

G. Dip-Pipes:
   1. Provide inside and outside surfaces of dip-pipes with corrosion barrier. 
   2. Surfacing veil for this corrosion barrier shall be same as specified for 
      tank.
3. Corrosion barrier shall consist of appropriate surfacing veil, backed by two layers of fiberglass mat.
4. If “ready-made” pipe is used, it shall have an equivalent internal corrosion barrier and shall have specified corrosion barrier applied to outside surface.

H. Brine Saturator Tank Insulation:
   1. Insulate Brine Saturator Tank with 2-pound density polyurethane foam for bottom 6 feet of vertical shell, 2-inch minimum thickness. Insulation shall be applied to tank structural laminate before laminate has hardened, bond the insulation to the tank wall.
   2. Provide protective exterior fiberglass laminate over polyurethane foam. Straight shell protective laminate shall incorporate joints as required for thermal expansion. Provide lip at joints to prevent water intrusion 1-inch minimum overlap.

2.04 APPURTENANCES

A. Sight glass tank level indication will be provided where shown or called for on the tank data sheets and shall be constructed of materials compatible with the chemical stored.

B. Sight Glass (Type 1):
   1. Tubular type PVC with 2-inch flanged connection.
   2. Furnish with valves, drain cock, Pyrex glass, and stainless steel guard rods.
   3. Parts coming in contact with liquid shall be either PVC or glass.
   4. Calibrate tank in 100-gallon increments and paint calibrations adjacent to level tube with graduations and boldface figures.
   5. Manufacturer and Product: Ernst Flow Industries; Model EFI-PVC.

C. Sight Glass (Type 2):
   1. Calibrate in 100-gallon increments.
   2. Abrasion and corrosion resistant.
   3. Mount using 1/2-inch Tygon tubing, PVC fittings, PVC isolation ball valve, and stainless steel hose clamps.

D. Supports:
   1. Pipe Supports:
      a. Provide for tank overflow pipes, loading pipes and recirculation pipes.
b. Spacing of supports shall be as recommended by fabricator, but shall not be greater than 4 feet on center.

c. As shown on Drawings, shall allow removal of pipe.

d. FRP complete with necessary bolts, nuts, and washers.

2. Level Probe Supports: FRP.

E. External access ladders shall be provided where shown on tank data sheets. Ladders shall meet applicable OSHA Standards and the building code:

1. Material: FRP. Uncoated or exposed carbon steel parts or fasteners will not be acceptable. Anchor ladder to the concrete base and bracket to the tank shell as required. Brackets shall be spaced no more than 6 feet apart.

2. Provide ladders with necessary assembly and mounting hardware. Mounts shall not penetrate tank wall. All mounting hardware shall be Type 316 stainless steel.

3. Anchor ladder side rails as required.

4. The ladder shall have a clear width of at least 16 inches, with rungs at least 3/4 inch in diameter and spaced not more than 12 inches apart, and a clearance of at least 12 inches between the back of the ladder and the tank wall. Ladder shall extend beyond tank bottom to within 12 inches of containment floor, which is 2 feet below top of concrete tank pad.

F. Lifting Lugs: Provide suitably attached for tank weighing over 100 pounds.

G. Anchor Bolts: Type 316 stainless steel bolts, sized by fabricator, and 1/2-inch minimum diameter.

H. Manway Bolts: Type 316 stainless steel.

2.05 SOURCE QUALITY CONTROL

A. Identify and retain cutouts. Engineer may select certain cutouts for testing for physical properties of laminate.

B. Factory Test Reports:

1. Certify results, by signature, of the following:
   a. Inspections.
   b. Results of hydrostatic testing.
   c. Test reports of physical properties of standard laminates.
PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with fabricator’s written instructions.

B. Accurately place anchor bolts using templates furnished by fabricator, and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD QUALITY CONTROL

A. Functional Test:
   1. Conduct on each tank.
   2. Hydrostatic leak test with tank full of clean water. Allow water to stand for 24 hours to verify no leakage.

3.03 MANUFACTURER’S FIELD SERVICES

A. Provide fabricator’s representative at Site in accordance with Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Equipment Testing and Facility Startup, for installation assistance, inspection and certification of proper installation and startup assistance for specified component, subsystem, equipment, or system.

3.04 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are part of this specification.
   1. Brine Saturator Tank Data Sheet.
   2. Sodium Hypochlorite Tank Data Sheet.

END OF SECTION
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NOZZLE SCHEDULE

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ACCESSORIES

| Level Indicator  | |
| Ladder          | Int | Ext |
| Anchor Lugs     | X    |     |
| Lifting Lugs    | X    |     |
| Inlet Baffle     |     |     |
| Access Manway   | X    | SIDE AND TOP |
| Thief Hatch     | X    | RATED FOR 5000 LBS |
| Sloped Floor    |     |     |
| Weir Box        |     |     |
| Pipe Supports   | X    |     |
| Heat Trace      | X    |     |
| Insulate        | X    |     |
| Access Port     | X    |     |
| V-Floor Section |     |     |

NOTES:

1. SEE SPECIFICATIONS FOR OTHER DETAILS.
2. TANK REQUIRES FULL BOTTOM SUPPORT.
3. PROVIDE 1/4" DIAMETER VENT HOLE IN FILL LINE INSIDE NEAR THE TOP. PROVIDE FILL LINE INSIDE OF TANK DOWN TO 1-FOOT ABOVE BOTTOM OF TANK.
GENERAL INFORMATION

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ACCESSORIES

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<td>V-Floor Section</td>
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PHASE IV BEAVER CREEK WATER SUPPLY

JACOBS

TANK DATA SHEET

APPLICABLE TO:

- PROPOSAL
- PURCHASE
- RECORD

Information not specified to be supplied by vender as applicable

Item No. P20T0117

SODIUM HYPOCHLORITE TANK

Project No. 707765.FD.01 Date APRIL 2019

Requisition No. X Inquiry No. X

Purchase Order No. X Revision X

FIBERGLASS REINFORCED PLASTIC TANK

43 40 02 SUPPLEMENT - 1

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DECEMBER 2019
SECTION 44 42 25.01
PREFABRICATED ALUMINUM COVERS

PART 1  GENERAL

1.01 WORK OF THIS SECTION

A. This Section is for a fully engineered, substantially airtight, surface mounted aluminum cover structure comprised of panels, support beams and members as required to completely cover Raw Water Intake Pump Station areas indicated on Drawings.

B. Furnish all labor, materials, and equipment to provide a complete, installed system of fixed and removable, custom fit, flat aluminum covers. The Raw Water Intake Pump Station system includes cover panels, structural supports, and attaching hardware.

1. Facilities with flat panel covers as shown on Drawings:
   a. Raw Water Intake Pump Station.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

2. ASTM International (ASTM):

1.03 SUBMITTALS

A. Action Submittals:

1. Drawings or catalog cuts required for the fabrication and installation of the covers, accurate in every detail and containing information necessary to relate to Drawings and Specifications.
2. Complete manufacturer’s specifications, including material description.
3. Description of manufacturer’s standard finish.
4. List of materials and supplies furnished with the equipment.
5. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.
B. Informational Submittals:

1. Complete structural calculations showing the governing stresses in all members and connections, and detailed shop drawings. Drawings shall be stamped by Engineer licensed in the State of Oregon.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
4. Manufacturer’s Certificate of Compliance, in accordance with Section 01 61 00, Common Product Requirements.
5. Approximate shipping weight of the equipment and, if shipped unassembled, the number of components and approximate weight of each.
7. Recommended handling method.
8. Requirements for storage and protection prior to installation.
9. Recommended spare parts and cost information.
10. List of special tools furnished with the equipment.
11. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: 5 years of experience in design, fabrication, and erection of structures proposed.

B. Designer: Professional engineer registered in the state where Project is to be constructed.

C. Erectors: Trained and approved by the manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide suitable lugs or other devices for attachment of lifting lines.

B. Provide spreaders as required to avoid damage to the cover.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Ultraflote, Houston, TX.
2.02 FLAT COVERS

A. Flat Aluminum, Clear-span Structures:
   1. The aluminum cover shall be composed of panels and beams, as required. All panels shall interlock with the adjoining beams without the use of threaded fasteners.
   2. Self-supporting from basin walls or slab as shown on Drawings.
   3. Beams, as required, shall be located below the panel surface and sized to clear interior piping and accessories by a minimum of 1 inch.
   4. Allow for thermal expansion and contraction.
   5. Walking surface elevation: Installed cover system walking surface elevation to be flush or no more than 2 inches above top elevation of concrete walls.

B. Lifting Lugs: Provide suitably attached for assemblies and components weighing over 100 pounds.

2.03 DESIGN

A. Conform to generally accepted engineering practice, and to the “Specifications for Aluminum Structures” published by the Aluminum Association.

B. Design Stress: All allowable design stresses in structural aluminum shall be in accordance with the “Specifications for Aluminum Structures” for building-type structures by the Aluminum Association.

C. Design the covers to withstand their own dead load plus the following loads:
   1. Snow Load: 25 pounds per square foot over the total area.
   2. Wind Load: See General Structural Notes on Drawings for Criteria. Design for horizontal and uplift forces in accordance with ASCE 7, except as modified herein.
   3. Uniform Live Load: 50 pounds per square foot.
   4. Concentrated Load: 400-pound load concentrated on 1 square foot at any point.
   5. Seismic Load: See General Structural Notes on Drawings for Criteria.

D. Maximum deflection of cover system components subject to Dead plus Live loading shall be the span length divided by 240.

E. Configuration:
   1. Furnish covers with an integral nonskid surface, without the use of paint or adhesive tapes.
2. Decking Surface:
   a. Interlock edges of adjacent deck slats so that the slats act together.
   b. Dovetail interlocks that are easy and readily available to remove may be used to hold adjacent panels together. Panels designated and shown shall be removable without removing adjacent panels.

3. At the location of removable panels, furnish cover structure with provision for a temporary handrail system.

   a. Panels: Interlock with the adjoining beam without the use of threaded fasteners.
   b. Join panels and beams with quickly removable interlocking plastic or aluminum pins that are removable without the use of tools.
   c. Weight of Individual Panels: Not to exceed 150 pounds.

5. Removable Panels: Require no more lifting force than the dead weight of the panel.

6. Covers shall be designed and detailed for pipe penetrations that allow cover removal without disconnect or removal of penetrating piping. Design and detail covers for instrument mounting as shown on Drawings.

2.04 COMPONENTS


B. Aluminum Panels for Flat Covers: 0.09-inch minimum thickness, alloy 5052-H36 or 6061-T6 aluminum sheet.

2.05 ACCESSORIES

A. Furnish doors, hatches, vents, and pipe penetrations of manufacturer’s standard design equivalent to those indicated on Drawings.

B. Access Hatch Panels:
   1. Locations and clear opening as identified on Drawings.
   2. Integral gear hinged access hatches.
   3. Identical properties as the rest of the aluminum cover including loads, deflection and slip resistance specifications.

C. Fasteners:
   1. Between Aluminum Components: Stainless steel or structural plastic.
   2. Provide protection from dissimilar metals by means of gasketing or painting system as specified.
3. Anchor Bolts and Threaded Fasteners: Type 304 or Type 316 stainless steel as specified in Section 05 05 19, Post-Installed Anchors.
4. Supply a sufficient quantity of adhesive anchor or anchor bolts of suitable size to avoid localized stresses in bolting.

2.06 MISCELLANEOUS MATERIALS

A. Bearing Pads: Teflon-coated Series 300 stainless steel bearing plates with a maximum 10 percent friction coefficient and with anchors in radially or laterally slotted holes so that no more than 10 percent of the maximum vertical reaction at the support can be transmitted in horizontal thrust to the support wall.

B. Slide Plates: Series 300 stainless steel.

C. Sealant: Type 1 as specified in Section 07 92 00, Joint Sealants.

2.07 FABRICATION

A. Welding:
   1. Components to be welded shall be free of dirt, grease, and other contaminants, and shall fit up properly for sound welding.
   2. Surfaces to be welded may not be cut with oxygen; sawing, shearing, or machining may be used.
   3. Use inert gas shield arc process.
   4. Develop machine settings with test welds of the same material, alloy, and geometry as the work pieces.
   5. Destructively test sample welds.

B. Seals: Replaceable and mechanical with no caulking allowed.

C. Finishing: Exposed surfaces of the structure shall be given AA-M44 (coarse matte) finish after fabrication.

PART 3 EXECUTION

3.01 ERECTION

A. Provide suitable equipment for assembly and installation of the covers.

B. Erection shall be supervised by the cover manufacturer and performed by skilled and experienced mechanics in accordance with the manufacturer’s standards.
C. Erect plumb and level and in proper alignment.

D. Field cutting and patching will be permitted only with the Engineer’s approval.

END OF SECTION
EQUIPMENT AND COMPONENT NUMBER(S)

Booster Pump 1: D560011.
Booster Pump 2: D56P0012.
Field Panel: D56FP0010.

PART 1 GENERAL

1.01 WORK OF THIS SECTION

A. The Section covers the Work necessary to provide one prefabricated packaged pump station, complete with all related station equipment, components, and field panel, and ready for all installation, including all appurtenances as specified herein. Packaged pump station shall be ready for operation upon delivery, except for the necessary piping and utility connections.

1.02 GENERAL

A. Unit Responsibility: A single System Supplier shall be responsible for supplying the packaged pump station, complete with all accessories and appurtenances (including, but not necessarily limited to, pumps, electric motors, field panel, safety guards, pump skid piping and valves, instrumentation, fiberglass pump skid enclosure and spare parts) and for the design, fabrication, assembly, delivery, and installation supervision. The System Supplier shall furnish all components and accessories of the packaged pump station to enhance compatibility, ease of operation and maintenance, and as necessary to place the equipment in operation in conformance with the specified performance, features, and functions.

1.03 ANCHORAGE DESIGN REQUIREMENTS

A. Provide applicable stamped Drawings and calculations for anchorage and bracing in conformance with Section 01 88 15, Anchorage and Bracing.

1.04 REFERENCES

A. The Work in this Section is subject to the requirements of the applicable portions of the following standards:

3. ASTM International (ASTM).
4. Institute of Electrical and Electronics Engineers (IEEE).
9. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
10. Occupational Safety and Health Act (OSHA).
12. UL 508.

1.05 SUBMITTALS

A. Submittals shall be made in accordance with Section 01 33 00, Submittal Procedures.

B. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Detailed mechanical and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
   d. Power and control wiring diagrams, including terminals and numbers. Diagrams shall include, but are not limited to:
      1) One-line diagrams showing power distribution and load sizes in hp, Amps, or kW.
      2) Motor control diagrams showing starter, including all input and output wiring with terminal numbers.
   e. Control wiring diagrams showing all customer field connections including terminal block numbers.
   f. Panel construction drawings and bill of material.
   g. Equipment data for all electrical components, including, but not limited to:
      1) Wire.
      2) Conduit.
      3) Panelboards.
      4) Receptacles.
h. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications and as specified in Section 26 20 00, Low-Voltage AC Induction Motors.
i. Manufacturer’s Standard Details and Structural Calculations: Clearly mark those portions that apply to specific Project and those parts that do not apply.
j. Manufacturer’s Literature and Technical Data: Drawings and Specifications for proposed building system.
k. Painting Systems: Specifications including paint manufacturer’s name, product trade-name, and preparation for shop and field coats.
l. Dimensional drawings of fiberglass enclosure.
m. Enclosure heater calculations.

C. Informational Submittals:

1. Factory Functional and Performance Test Reports and Log.
2. Manufacturer’s printed installation instructions.
3. Manufacturer’s Certificate of Proper Installation.
4. Certification that codes and referenced standards have been met and approved by Building Codes Division.
5. Calculations Stamped by Manufacturer’s Engineer:
   a. Complete structural stress and deflection analysis of structural components and connections.
6. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

B. Packaged pump station shall consist of a prefabricated fiberglass enclosure, as described herein, and include a skid based pumping system, with all required equipment installed, fully integrated and connected, and delivered complete and essentially ready to operate after installation by the Contractor. Packaged
pump station shall have all interconnecting piping, cabling and raceway pre-installed, ready for connection to supply, and discharge piping and utility service by Contractor.

C. Pumping system shall include piping, isolation valves, instruments, gauge assemblies, field panel, and other equipment and station appurtenances as shown on Drawings and described herein.

D. Pumping system shall include a triplex booster pump system (two pumps installed with space for a future pump of identical size) including suction and discharge piping and valves for all three pumps.

2.02 SYSTEM SUPPLIER

A. The packaged pump station System Supplier shall have at least 5 years’ experience in the design, application, and supply of packaged pump stations.

B. System Supplier shall have provided packaged pump stations at a minimum of five reference installations.

C. The packaged pump station shall be supplied by the following listed System Supplier, furnished as modified to conform to the performance, functions, features, and materials of construction as specified herein:

1. Granich Engineered Products, Inc.
   1313 South 96th Street
   Seattle, WA 98108
   Main Phone: (206) 315-2940
   Contact: John Hayes

2.03 SERVICE CONDITIONS

A. Pumped Fluid: Potable water.

B. Ambient Temperature Range: 25 degrees F to 89 degrees F.

C. Altitude: 167 feet above mean sea level.

D. Approximate Pump Suction Header Pressure: 40 psig.

2.04 DESIGN REQUIREMENTS

A. Pump total dynamic head performance requirements specified herein shall be increased to account for friction losses due to pump skid manifold piping and valves.
2.05 PERFORMANCE REQUIREMENTS

A. Booster Pumps (Each):
   1. Suction Pressure: Specified under Service Conditions.
   2. Rated Capacity: 400 gpm.
   3. Total Dynamic Head: 50 feet.

2.06 BOOSTER PUMP SKID CONSTRUCTION DETAILS

A. Booster pump skid shall be a standard product of a single pump manufacturer, modified to conform to the performance, functions, features, and materials of construction specified herein. The entire pump system, including pumps and field panel shall be designed, built, and tested by the same manufacturer.

B. All pumps, piping, valves, and appurtenances of the pumping system in contact with the pumped fluid shall be ANSI/NSF 61 Annex G listed for drinking water and low lead requirements.

C. Suction and discharge manifold construction shall minimize pressure drops and potential for corrosion and prevent bacteria growth at intersection of piping into the manifold. Manifolds and other piping shall be constructed of NSF 61 approved epoxy lined and coated black carbon steel pipe, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW All threaded pipe and pipe 1-1/2 inches and smaller shall be Schedule 80. Pipe 2-inches and larger shall be standard weight. Flanges shall be forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 slip-on or welding neck, raised face. Flange bolting shall be Alloy steel ASTM A193, Grade B heavy hex head or stud bolts; ASTM A194, Grade 2H heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. The main header and connection flanges to and from the distribution system shall be ANSI Class 150, 8-inch diameter minimum based on the future flow condition of 800 gpm with two pumps in operation Pump connection sizes shall be selected to match the pumps provided and to meet Hydraulic Institute Standards for pump suction piping.

D. Provide pump isolation valves on the suction and discharge of each pump. Isolation valves sized 2 inches and smaller shall be nickel plated brass full port ball valves. Valves sized greater than 2 inches shall be lug style butterfly valves with bronze disk, and Buna or EPDM seat.

E. Provide silent check, spring-return type check valves on the discharge of each pump. Valves shall be flanged or wafer style type fitted being two pipe flanges.
F. Provide one pressure switch in the common suction manifold. Pressure switch in the suction manifold shall be used for water shortage protection.

1. Manufacturers and Products:
   a. Ashcroft; Type 400, B Series.
   b. United Electric; 400 Series.

G. Provide bourdon tube pressure gauge, 4.5-inch diameter, in each of the common suction and discharge manifolds.

1. Manufacturers and Products:
   a. Ashcroft; Duragauge Model 1259.
   b. WIKA; Type 2XX.34.
   c. “Or-equal.”

H. Provide one electromagnetic flowmeter with local indication and 4 mA to 20 mA output to monitor the pump station discharge flow.

1. Manufacturers and Products:
   b. Endress+Hauser; Promag L400.

I. Pump skid base frame shall be fabricated of carbon steel with designed anchorage points. Frame shall be coated as described in this Section.

2.07 BOOSTER PUMPS

A. Pumps shall be of the horizontal end suction direct-coupled design.

B. The head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. The shutoff head shall be a minimum of 20 percent higher than the head at the best efficiency point.

C. Pump power shall not overload the motor nameplate power on any point of the curve.

D. Pump Speed: 1,750 rpm, constant speed. The pump suction/discharge connections shall have ANSI Class 150 flange connections.

E. Materials of Construction shall comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372. All materials shall be industry standard for pumps pumping potable water.

F. Manufacturer and Product:

1. Pentaire, Fairbanks Nijhuis: 1500 1 STG ENDSUC.
2. “Or-equal.”
2.08 **BOOSTER PUMP DRIVE MOTORS**

A. Provide TEFC motors rated 7.5 hp, 240 volts, single-phase, 60-Hz at synchronous speed of 1,800 rpm.

B. Provide motors in accordance with Section 26 20 00, Low-Voltage AC Induction Motors.

2.09 **ELECTRICAL**

A. All power shall be derived from control panel furnished and installed as part of the packaged pump station. The control panel will be fed 240V, single-phase utility power from a service entrance rated disconnect and meter mounted on the outside wall of the pump station structure (service equipment on outside wall shall be provided by others, outside of this Section). Control panel shall handle protection and distribution to motor starters as well as protection and distribution for heat trace and any instrumentation. Control power transformer shall be utilized for powering all 120V ac and lower circuits. Coordinate service equipment location and installation with others, and provide conduit sleeves through exterior walls as necessary.

B. Provide one GFCI receptacle mounted within field panel enclosure.

C. All conduit shall be rigid Schedule 80 PVC. All wiring shall be THHN, except wiring for power distribution and power to the pump field panel and pumps shall be XHHW/XHHW-2.

2.10 **BOOSTER PUMP SYSTEM CONTROLS**

A. The booster pump system field panel shall be a standard product developed and supported by the pump manufacturer.

B. Field Panel Enclosure: NEMA 1.

C. Motor Starters:

1. Located in the Field Panel.
2. Provide a NEMA rated combination nonreversing starter for Pump 1 and Pump 2 and space for future Pump 3 starter.

D. Operator Controls and Indications:

1. Provide the following indicating lights, switches, and pushbuttons:
   a. ON/OFF/REMOTE selector switch, each pump.
   b. Pump ON green indicating light, each pump.
   c. Suction pressure LOW yellow indicating light.
d. Indicating lights shall be push to test type.

E. External Interfaces:

1. Discrete Inputs:
   a. Booster Pump 1 RUN.
   b. Booster Pump 2 RUN.
   c. Future Booster Pump 3 RUN.

2. Discrete Outputs:
   a. Booster Pump 1 in REMOTE.
   b. Booster Pump 2 in REMOTE.
   c. Future Booster Pump 3 in REMOTE.
   d. Booster Pump 1 ON.
   e. Booster Pump 2 ON.
   f. Future Booster Pump 3 ON.
   g. Suction pressure LOW.

3. Analog (4 mA to 20 mA) Outputs: Discharge flow.

2.11 FIBERGLASS ENCLOSURE

A. The walk-in enclosure shall cover the entire pump skid and field panel. The enclosure shall include access doors to readily provide access to all components within the enclosure with direct access to the face of the field panel. Enclosure and doors shall be insulated. Insulation type and R-value requirements to be determined by manufacturer, in conjunction with the heater sizing, to maintain the enclosure temperature as stated below.

B. All doors shall be lockable with a standard pad lock provided by others. Door handles and hinges shall be constructed of Type 304 or Type 316 stainless steel.

C. Provide the enclosure with 240V, single-phase, 60-Hz heater(s). The heater shall be thermostat controlled and designed to maintain the enclosure temperature above 40 degree F with an outdoor temperature of 25 degrees F.

2.12 ANCHORAGE

A. Provide embedded plates for anchorage as indicated on Drawings.

2.13 ACCESSORIES

A. Identification Plate: A 16-gauge stainless identification plate shall be securely mounted on each pump in a readily visible location. The plate shall bear the 1/2-inch die-stamped equipment identification number that is assigned herein and shown on Drawings.
B. Lifting Lugs: Equipment over 50 pounds in weight shall be provided with lifting lugs.

2.14 SOURCE QUALITY CONTROL

A. Hydrostatic Testing: Skid pumping system shall be filled with water and pressurized to the greater of the following two values: 1.5 times the maximum pump nameplate pressure or 350 psig for systems with 150-pound flange connections. Test pressure shall be maintained for a minimum of 15 minutes with no leakage, except for minor leakage around pump(s) mechanical seal.

B. Functional Testing: The entire pump station shall be factory tested for functionality. Functional testing shall confirm proper motor and pump coupling and rotation, low vibration, and proper function of all instruments and control features.

PART 3 EXECUTION

3.01 INSTALLATION

A. Unit shall be installed in accordance with the manufacturer’s written instructions and as shown on Drawings.

3.02 FIELD QUALITY CONTROL

A. Prior to pump station startup, the equipment described herein shall be inspected for proper alignment, correct rotation, quiet operation, proper connection by means of a functional test.

B. Performance Test:

1. Conduct on each pump.
2. Perform under simulated operating conditions.
3. Test for a continuous 3-hour period without malfunction.
4. Test Log:
   a. Record the following:
      1) Total head.
      2) Capacity.
      3) Horsepower requirements.
      4) Flow measured by discharge flow meter.
      5) Pump suction pressure converted to feet of liquid pumped and corrected to pump suction centerline.
      6) Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
      7) Driving motor voltage and amperage measured for each phase.
C. Provide manufacturer's Certificate of Proper Installation in accordance with Section 01 33 00, Submittal Procedures, of Division 01, General Requirements.

3.03 MANUFACTURERS' SERVICES

A. An equipment manufacturer's technical representative for the equipment specified herein shall be present in accordance with Division 1, General Requirements and shall be present at the jobsite and/or classroom designated by the Owner for the minimum person-days listed for the services hereunder travel time excluded:

1. 1 person-day for installation assistance, inspection, and written certification of the installation.
2. 1/2 person-day for functional testing.
3. 1/2 person-day for training of the Owner's personnel.

B. Training of Owner's personnel shall be at such times as requested by the Owner.

C. See Section 01 91 14, Equipment Testing and Facility Startup.

END OF SECTION
SECTION 44 42 56.03
SUBMERSIBLE TURBINE WELL PUMP

EQUIPMENT AND COMPONENT NUMBER(S)

Raw Water Pump No. 1: I10P0001.
Raw Water Pump No. 2: I10P0002.

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   d. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

2. Institute of Electrical and Electronics Engineers (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.

3. National Electrical Manufacturer’s Association (NEMA): MG 1, Motors and Generators.

4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.
1.03 SPECIAL GUARANTEE

A. The submersible turbine pumps shall have a 3-year extended guarantee or warranty, with Owner named as beneficiary, in writing. Extended guarantee period shall begin upon Substantial Completion. During the warranty period, if the submersible pump system shall fail to operate as designed, due to manufacturer or installation deficiencies, the Contractor shall be required to diagnose the cause of failure, correct the deficiency, and place the pump back into operation. The Contractor shall be required to incur all costs associated with removing the pump from the casing, repairing the system, and reinstalling the system as designed. The Owner will not incur any costs associated with removing, reinstalling, or repairing the pump, in the event the pump fails due to manufacturer or installation deficiencies.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of the pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at the guarantee point.
   d. Pump maximum downthrust or upthrust in pounds.
   e. Detailed structural, mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment. Structural drawings shall include surface plate and sole plate anchor details.
   f. Power and control wiring diagrams, including terminals and numbers.
   g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
   h. Factory finish system.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Compliance, that factory finish system is identical to the requirements specified herein.
3. Factory Functional and Performance Test Reports.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer’s printed installation instructions.
6. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption:
Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

B. Adjustable Speed Drives:

1. Furnish coordinated operating system complete with pump, driver, and adjustable frequency drive. The Adjustable Frequency drive is provided by Electrical and specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.
2. Coordinate pump and motor requirements with adjustable frequency drive manufacturer and be responsible for the following:
   a. Torsional vibration of rotating assembly and related stresses.
   b. Motor thermal rating.
   c. Structural design of pump and motor assembly.
   d. Drive capacity for actual motor’s nameplate current rating being supplied.
   e. Minimum motor speed rating for required corresponding torque.
2.02 PUMP ASSEMBLY

A. Pump Type: Multistage, vertical turbine pump, driven by a submersible, water filled, motor.

B. Strainer: The pump shall have a galvanized strainer that will not restrict the flow of water with an open area in excess of four times the throat area of the suction case.

C. Well Head Assembly:

1. The well head shall be provided by the pump supplier. The mounting flange shall include one 1-1/2-inch NPT tapped hole for a vent and two 3/4-inch NPT tapped holes for power cable and one spare, and two lifting lugs. The well head shall include a 90-degree discharge elbow with an 8-inch discharge flange. The assembly shall include a straight pipe spool between the mounting flange and the discharge elbow to provide the vertical dimension between the shroud/casing flange face and the discharge pipe centerline elevation as shown on Drawings. The mounting flange shall be designed to support the total weight of the pump/motor, discharge column full of water, and pump discharge elbow. The bottom of the mounting flange shall be provided with a threaded column coupling. The lifting eyes shall be sized for the entire assembly. All components shall be fabricated from ASTM A53, carbon steel pipe and suitable carbon steel components.

2. The wellhead shall include a ANSI B16.5, Class 150, 8-inch discharge flange. The mounting flange bolt holes shall be drilled to match the 16-inch pump shroud/casing flange per ANSI B16.5, Class 150 as shown on Drawings.

D. Pump Column: Pump column shall be Schedule 40, carbon steel per ASTM A53 with threaded connections to the mounting flange coupling and the pump discharge bowl. Column dimensions shall be based on the pump setting depth as shown on Drawings.

E. Pump must be purchased from an authorized representative of the manufacturer. Pumps must be assembled by the manufacturer.

2.03 MOTOR

A. The motor shall be a squirrel cage induction motor designed for water filling, water cooling, and water lubrication. Oil or grease lubricated motors are not acceptable.
B. The stator windings shall be directly immersible in water. The winding wire insulation shall consist of a waterproof, nonaging material of high di-electric strength. The winding insulation shall be reinforced by a polypropylene cover. Hermetically sealed or resin encased stators are not acceptable.

C. The stator windings shall be Hi-pot tested at twice rated voltage plus 1,000 volts. The insulation resistance shall be not less than 100 megohms.

D. The rotor shall be statically and dynamically balanced.

E. The thrust bearing shall be of heavy-duty tilting pad “KINGSBURY” design and shall be self-aligning. Motor shall have upthrust protection.

F. The motor shall be equipped with two rubber shaft seals.

G. The motor shall be equipped with a pressure regulator, drain plug, and filling device.

H. Motor Rating: 75 hp, 460-volt, three-phase, 60-Hz, 1,770 rpm.

I. Motor shall be suitable to be driven with an adjustable frequency drive provided under Electrical Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

2.04 CABLES

A. Power: The electrical cable shall be marine submersible type consisting of three stranded conductors of the proper size to carry the full amperes of the motor at rated voltage. The conductors shall be insulated in accordance with IPCEA requirements. The cable shall be supported on the column pipe by means of cable clamps and stainless steel bands. The cable shall terminate in the adjustable frequency drive panel located in the Intake Building Electrical Room. The cable shall have a watertight termination at the motor.

2.05 SUPPLEMENT

A. Some specific requirements are attached to this section as a supplement.

2.06 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.
2.07 FACTORY FINISHING

A. Pump column and well head assembly: Prepare and prime and finish coat and line in accordance with Section 09 90 00, Painting and Coating, System No. 1.

B. Pump and Motor: Manufacturer’s standard finish for potable water service.

2.08 SOURCE QUALITY CONTROL

A. Factory Test Report: Include test data sheets, curve test results, performance test logs, certified correct by a registered professional engineer.

B. Functional Test: Perform manufacturer’s standard, motor test.

C. Performance Test:
   1. Conduct per Hydraulic Institute Standards.
   2. Perform under simulated operating conditions.
   3. Test for a continuous 3-hour period without malfunction.
   4. Test Log:
      a. Record the following:
         1) Total head.
         2) Capacity.
         3) Horsepower requirements.
         4) Flow measured by factory instrumentation and storage volumes.
         5) Average distance from suction well water surface to pump discharge centerline for duration of test.
         6) Pump discharge pressure converted to feet of liquid pumped and corrected to pump discharge centerline.
         7) Calculated velocity head at the discharge flange.
         8) Driving motor voltage and amperage measured for each phase.
   5. Adjust, realign, or modify units and retest if necessary.

D. Hydrostatic Tests: Pump casing(s) tested at 150 percent of shutoff head. Test pressure maintained for not less than 5 minutes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation to be by a certified pump installer.

B. Provide supervision, labor, tools, construction equipment, incidental materials, and all services required to install the pump.
C. Installation of pump shall not begin prior to the satisfactory completion of the supporting structures.

D. Power cable to be strapped to column pipe every 10-feet or per manufacturer’s recommendation.

E. Verify direction of motor rotation.

3.02 FIELD FINISHING

A. Field touch up any coating damaged during handling or installation with the factory finish system specified herein.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.
   1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   2. Flow Output: Measured by plant instrumentation and storage volumes.

B. Performance Test: In accordance with Hydraulic Institute Standards.

3.04 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative: Present at site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   1. 1 person-day for installation assistance and inspection.
   2. 1 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
   3. 1 person-day for prestartup classroom or site training.
   4. 1 person-day for facility startup.

B. See Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.
   1. Raw Water Intake Pump Data Sheet.

END OF SECTION
**RAW WATER INTAKE PUMP DATA SHEET**

<table>
<thead>
<tr>
<th>LIQUID</th>
<th>OPERATING CONDITIONS</th>
<th>SERVICE CONDITIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name:  Water</td>
<td>Capacity (U.S. gpm):</td>
<td>Temp (°F): Max 100 Min 50</td>
</tr>
<tr>
<td>Pumping Temperature (°F): 50</td>
<td>Normal Rated 900</td>
<td>Rel. Hum (%): Max Min</td>
</tr>
<tr>
<td>Specific Gravity @ °F: 1.0</td>
<td>Total Dynamic Head (ft): 242</td>
<td>Altitude (ft): 10</td>
</tr>
<tr>
<td>Vapor Pressure (psia):</td>
<td>Suction Lift (psig):</td>
<td></td>
</tr>
<tr>
<td>Viscosity (CP) @ °F: Neutral</td>
<td>Max Rated</td>
<td></td>
</tr>
<tr>
<td>pH: Neutral</td>
<td>Submergence (min. ft.):</td>
<td></td>
</tr>
<tr>
<td>Corrosion/Erosion/Abrasion Caused by:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remarks:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remarks: *Bottom of motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump shall also be capable of turndown</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>to 450 gpm at 225 ft TDH</td>
<td></td>
</tr>
</tbody>
</table>

**PERFORMANCE REQUIREMENTS (manufacturer to supply missing data)**

<table>
<thead>
<tr>
<th>Proposal Curve No.: EC-2657</th>
<th>Min. Continuous Flow (gpm):</th>
<th>NPSH Required (ft water):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump Speed (rpm): Varies</td>
<td>Max. Head (ft): 245</td>
<td>3% Head Drop</td>
</tr>
<tr>
<td>Efficiency (%):</td>
<td>Max. Power (BHP):</td>
<td>Suction Specific Speed:</td>
</tr>
<tr>
<td>Rated Power (BHP): 75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Factory Testing:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remarks:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Drive Type:** ☑ Constant ☑ Adjustable
### PUMP CONSTRUCTION DETAILS

<table>
<thead>
<tr>
<th>Nozzles</th>
<th>Miscellaneous Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Suction</strong></td>
<td><strong>Size</strong></td>
</tr>
<tr>
<td><strong>Discharge</strong></td>
<td><strong>4-inch</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Casing Mount:</th>
<th>Impeller Type:</th>
<th>Bearings (Type/No.):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td>Open, Closed</td>
<td>Bowl, Bronze</td>
</tr>
<tr>
<td>Vertical Barrel</td>
<td></td>
<td>Lineshaft Pump Shaft, Buna N</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Max. Allowable Pressure (psig):</th>
<th>Rated</th>
<th>Max</th>
<th>Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 60°F:</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>At Norm. Pump. Temp.:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pump Shaft Dia. (In.):</th>
<th>No. of Stages:</th>
<th>4</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Column Size (In.):</th>
<th>8</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Lineshaft Type:</th>
<th>Lineshaft Size (In.):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open, Enclosed</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hydro Test Pressure (psig):</th>
<th>10</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Field Testing:</th>
<th>Remarks:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not required</td>
<td></td>
</tr>
<tr>
<td>Required, functional and performance</td>
<td></td>
</tr>
</tbody>
</table>

### MATERIALS

<table>
<thead>
<tr>
<th>Bowl: Cast iron (CI30)</th>
<th>Impeller: 316 SST</th>
<th>Shaft: 416 stainless steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowl Wear Rings: N/A</td>
<td>Impeller Wear Rings: N/A</td>
<td>Shaft Sleeve: N/A</td>
</tr>
<tr>
<td>Column: ASTM A53</td>
<td>Bowl Bearing: Bronze Bismuth</td>
<td>Well Head: ASTM A53</td>
</tr>
</tbody>
</table>

### ADDITIONAL REQUIREMENTS

- Mounting Flange, fabricated carbon steel
- Suction Strainer Yes
- Sufficient Power Cable to Mounting Flange Plus 100 feet
SECTION 44 42 56.11  
VERTICAL MULTISTAGE CENTRIFUGAL PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

Finished Water Pump No. 1: P30P0011.  
Finished Water Pump No. 2: P30P0012.  
Finished Water Pump No. 3: P30P0013.

PART 1  GENERAL

1.01  REFERENCES

A.  The following is a list of standards which may be referenced in this section:

1.  American Bearing Manufacturers’ Association (ABMA).
2.  Hydraulic Institute Standards.
3.  National Electrical Manufacturer’s Association (NEMA): MG 1, Motors and Generators.
4.  NSF International (NSF):
   a.  NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b.  NSF/ANSI 372, Drinking Water System Components - Lead Content.
5.  Occupational Safety and Health Administration (OSHA).

1.02  DEFINITIONS

A.  Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.

1.03  SUBMITTALS

A.  Action Submittals:

1.  Shop Drawings:
   a.  Make, model, weight, and horsepower of each equipment assembly.
   b.  Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c.  Performance data curves showing head, capacity, horsepower demand, and pump efficiency over entire operating range of pump from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand, overall efficiency, and minimum submergence required at guarantee point.
d. Detailed drawings showing equipment dimensions, size, and locations of connections and weights of associated equipment.
e. Power and control wiring diagrams, including terminals and numbers.
f. Complete motor nameplate data in accordance with Section 26 20 00, Low-Voltage AC Induction Motors.
g. Factory finish system data sheets.
h. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s Certificate of Compliance, that factory finish system is identical to the requirements specified herein.
3. Factory Functional and Performance Test Reports.
4. Special shipping, storage and protection, and handling instructions.
5. Manufacturer’s printed installation instructions.
6. Suggested spare parts list to maintain the equipment in service for a period of 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
7. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
8. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
9. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps:

1. Complete set bearings.
2. Complete set gaskets and O-ring seals.
3. Complete set keys, dowels, pins, etc.
4. Complete mechanical seal.
5. Impeller.
6. Head shaft.
7. One complete set of special tools required to dismantle pump.
PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

B. Adjustable Speed Drives:

1. Furnish coordinated operating system complete with pump, driver, and adjustable frequency drive. The Adjustable Frequency drive is provided by Electrical and specified in Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

2. Coordinate pump and motor requirements with adjustable frequency drive manufacturer and be responsible for the following:
   a. Torsional vibration of rotating assembly and related stresses.
   b. Motor thermal rating.
   c. Structural design of pump and motor assembly.
   d. Drive capacity for actual motor’s nameplate current rating being supplied.
   e. Minimum motor speed rating for required corresponding torque.

2.02 PUMP TYPE

A. Vertical inline multistage centrifugal pump.

2.03 MOTOR

A. Motors shall meet applicable requirements of Section 26 20 00, Low-Voltage AC Induction Motors. Also refer to Supplemental Induction Motor Data Sheets attached.

B. Motor horsepower shall be determined by the manufacturer and sufficient to provide pumping as specified on supplemental data sheets. Substantiation of recommended horsepower shall be provided with Shop Drawings. Maximum horsepower is listed in the supplements to this section.
2.04 SUPPLEMENTS
A. Refer to the data sheets attached to the end of this section as supplements.

2.05 ACCESSORIES
A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch diespaced equipment tag number securely mounted in a readily visible location.
B. Lifting Lugs: Equipment weighing over 100 pounds.
C. OSHA-approved coupling guard for direct coupled or belt driven pumps.
D. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications.

2.06 FACTORY FINISHING
A. Provide manufacturer’s standard finish with linings in contact with the pump fluid suitable for drinking water.

2.07 SOURCE QUALITY CONTROL
A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.
B. Factory Tests and Adjustments: Test all equipment actually furnished.
C. Factory Test Report: Include test data sheets and curve test results.
D. Functional Test:
   1. Perform manufacturer’s standard, motor test on equipment. Include vibration test, as follows:
      a. Dynamically balance rotating parts of each pump and its driving unit before final assembly.
E. Performance Test: Adjust, realign, or modify units and retest if necessary.
F. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install in accordance with manufacturer’s printed instructions.
B. Adjust pump assemblies such that the driving units are properly aligned, plumb, and level with the driven units and all interconnecting shafts and couplings. Do not compensate for misalignment by use of flexible couplings.

C. Connect suction and discharge piping without imposing strain to pump flanges.

D. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING

A. Finish equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Functional Tests: Conduct on each pump.
   1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.
   2. Flow Output and Pressure: Measured by plant instrumentation and storage volumes.
   3. Operating Temperatures: Monitor bearing areas on pump and motor for abnormally high temperatures.

B. Performance Test:
   1. All equipment provided under this section shall be tested to demonstrate compliance with the specified equipment performance requirements including motors, instruments, and all accessories and components.
   2. In addition, all equipment provided under this section shall be tested as part of Performance Acceptance Testing.
   3. Refer to Section 01 91 14, Equipment Testing and Facility Startup, for additional requirements.

3.04 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative: Present at Site or classroom designated by Owner and Engineer, for minimum person-days listed below, travel time excluded:
   1. 1 person-day for installation assistance and inspection.
   2. 1 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
   3. 1 person-day for prestartup classroom or Site training.
   4. 1/2 person-day of training from each vendor.
5. 1/2 person-day of testing and field services.

B. See Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Testing, Integration, and Startup.

3.05 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this Specification.

1. Finished Water Pump No. 1, No. 2, and No. 3 Data Sheet.

END OF SECTION
FINISHED WATER PUMP NO. 1, NO. 2, AND NO. 3 DATA SHEET

Tag Numbers: P30P0011, P30P0012 and P30P0013

Pump Name: Finished Water Pump No. 1, No. 2, and No. 3

Manufacturer and Model Number: (1) Fairbanks
(2) “Or-equal”

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): Finished Water

Pumping Temperature (Fahrenheit) Normal: 50 Max 100 Min 40

Specific Gravity at 60 Degrees F: 1.0 Viscosity Range: 1 cp

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Total suspended solids (mg/L) 

Min. NPSH Available (Ft. Absolute): 20

Suction Pressure (Ft): Max 

Location: Indoor (Y/N): Y Outdoor (Y/N): N

PERFORMANCE REQUIREMENTS

Capacity (US gpm) Rated: 600

Total Dynamic Head (Ft) Rated: 30

Min. Hydraulic Efficiency (%): 78

Maximum Shutoff Pressure (Ft):

Max. Pump Speed at Design Point (rpm): 1,150

Constant (Y/N): N Adjustable (Y/N): Y

DESIGN AND MATERIALS

ANSI (Y/N) Standard (Y/N) Design: Frame-mounted (Y/N)
Vertical Close-Coupled Casing (Y/N) Y Back Pullout (Y/N)

Discharge Orientation: Inline Rotation (view from end coupling): 

Casing Materials:
PHASE IV BEAVER CREEK WATER SUPPLY

Case Wear Ring (Y/N) Y Material: 

Impeller: Type: Material: 

Impeller Wear Ring (Y/N): Material: 

Shaft Material: Shaft Sleeve Material: 

Shaft Seal: Packing (Y/N) Material: 

Mechanical (Y/N) Y Type: Single 

Lubrication: 

ABMA L-10 Bearing Life (Hrs): 50,000 Lubrication: 

Coupling: Falk (Y/N) Fast (Y/N) 

Spring-Grid (Y/N) 

   Gear Type (Y/N) Spacer (Y/N) Manufacturer 
   Standard (Y/N) 

Baseplate: Design: Material: 

Drive Type: Direct-Coupled: Belt Adjustable Speed 

Other: Materials to be Manufacturer Standard, compliant with NSF/ANSI 61 and NSF/ANSI 372

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 7.5 Voltage: 460 Phase: 3 Synchronous Speed (rpm): 1,200 

Service Factor: 1.00 Inverter Duty (Y/N) Y 

Motor nameplate horsepower shall not be exceeded at any head-capacity point on the pump curve.

Enclosure: DIP EXP ODP TEFC X CISD-TEFC TENV WPI WPII SUBM 

Mounting Type: Vertical Nonreverse Ratchet (Y/N) N 

Adjustable Speed Drive Range: 50% min to 100% max. See Section 26 29 23, Low-Voltage Adjustable Frequency Drive Systems.
REMARKS: Three additional design points, turndown to 200 gpm at 30 feet TDH, 600 gpm at 13 feet TDH, 200 gpm at 13 feet TDH.
SECTION 44 43 38
FISH SCREENING SYSTEM

EQUIPMENT AND COMPONENT NUMBER(S)

Screen Cleaner Control Panel: I10CP0010.
Air Compressor: I10AC0010.
Receiver: I10T0010.
Intake Screen.

PART 1 GENERAL

1.01 SUMMARY

A. This Section covers the work and materials necessary for the design, fabrication, delivery, installation, startup, and operation training for the river intake screens. The specific design and fabrication details for the screens and cleaning systems shall be the responsibility of the Contractor. Shop Drawings shall be submitted as specified herein.

1.02 GENERAL

A. The screen, air backwash manifold and backwash system, air compressor and receiver, manifold and fast-acting valves on air lines, and associated controls shall be designed and furnished by a single supplier.

B. The screen shall comply with the following requirements for the river intake, which have been established by regulatory agencies:

1. The screen shall be aligned with the river bank.
2. The approach velocity at the 900 gpm capacity shall be 0.4 fps or less.
3. The maximum screen angle is 45 degrees.
4. The screen shall be slotted with openings less than or equal to 1.75 mm.

C. Supplier can propose minor adjustments to sizes and pressures of equipment, provided the regulatory requirements are met and that Supplier coordinates changes with General Contractor at no cost to Owner.

1.03 DEFINITIONS

A. Standard Cubic Foot Per Minute (scfm): Volume flow rate of air at standard conditions of 60 degrees F, 14.7 psia, and 36 percent relative humidity.
1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Complete catalog information, descriptive literature, specifications, and identification of materials of construction for all equipment items provided.
   b. Detailed mechanical and electrical drawings showing the equipment dimension, size, connection locations and weights of associated equipment.
   c. Manufacturer’s diagrams for air compressor piping.
   d. Wiring diagrams showing all panel and field wiring connections including readily identifiable customer connections with terminal block numbers.
   e. Complete motor nameplate data, per Section 26 20 00, Low-Voltage AC Induction Motors.
   f. Power and control wiring diagrams.
   g. Factory finish systems.

2. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Provide structural calculation which demonstrates the equipment meet the anchorage criteria as specified in Section 01 88 15, Anchorage and Bracing.

2. Provide calculations to support size selection for backwash air receiver.

3. Quality Control Submittals:
   a. Operation and Maintenance Manuals: Contractor shall furnish an equipment Operation and Maintenance Manual. This manual shall include maintenance and operating instructions for all equipment and shall conform to Section 01 78 23, Operation and Maintenance Data. The manual shall include, but not necessarily be limited to, the following items:
      1) Equipment Manual:
         a) Operation description and component list.
         b) Description of operational tests.
         c) General trouble-shooting procedure.
         d) Recommended spare parts list.
         e) Electrical wiring diagrams.
         f) Control diagrams.
      2) Preventive Maintenance and Lubrication Schedule.
4. Operating Instructions: The Contractor shall instruct the Owner on the operation and maintenance of all equipment and systems. Each piece of equipment shall be provided with a complete set of printed operation and maintenance instructions and control diagrams, as required above.

1.05 DELIVERY, STORAGE, AND HANDLING OF EQUIPMENT AND MATERIALS

A. Insofar as is practical, the equipment specified herein shall be factory assembled. The parts and assemblies that are, of necessity, shipped unassembled shall be packaged and tagged in a manner that will protect the equipment from damage and facilitate the final assembly in the field. Generally, machined and unpainted parts shall be protected from damage by the elements of weather with the application of a strippable protective coating.

1.06 SPARE PARTS AND SPECIAL TOOLS

A. One complete set of any special tools required to service the equipment.

B. Four 2-inch shouldered eye bolts for installation/removal of fish screen panels as shown.

C. Compressor V Belts: One.

D. Compressor Intake Filter Cartridges: Three.

PART 2 PRODUCTS

2.01 SCREEN

A. Manufacturers:

1. Hendrick Screen Company.
2. Johnson Screen.

B. Type: Wedge wire.

C. Configuration: Flat screen panel with frame reinforcement, screen wire oriented vertically with 1-inch by 1/4-inch banding all around.

D. Materials: Type AISI 316 stainless steel.

E. Dimensions: As shown on Drawings.

F. Flow Capacity: 900 gpm.

G. Maximum Slot Opening: 1.75 mm (approximately 1/16 inch).
H. Effective Open Area: 45 percent (minimum).

I. Design Criteria:
   2. Under the design loading, deflection of the screens shall be limited to the span length \( L \) divided by 360 (\( L/360 \)).

J. Structural Members: Form slots by parallel wires of tapered cross-section welded or mechanically connected to support rods at a right angle to the wire with the flat base of the triangle to the outside. The size and number of internal supports shall be sufficient to meet the design requirements specified herein and to resist internal pressure created by the air backwash operation.

K. Screen Panel Frame: Stainless steel 2-inch by 2-inch tubing continuously butt welded at corners. Provide sleeves for bolting to concrete structure as shown on Drawings.

2.02 AIR BACKWASH SCREEN CLEANER SYSTEM

A. General: The air backwash screen cleaner system shall be complete and shall consist of air backwash manifold, an air compressor, motor and motor starter, air receiver, control panel, piping, valving, wiring and associated accessories mounted on a single skid. The compressor, receiver, and motor sizing is to be confirmed per screen manufacturer’s standard recommendations.

B. The air backwash screen cleaner system skid shall be delivered pre-wired and plumbed.
   1. Skid Power Supply: Single 480-volt, three-phase, 60-Hz power supply shall provide power to the Screen Cleaner Control Panel.

C. Backwash Control Valve: Furnish ball valve with double acting, pneumatic actuator, suitable for quick opening. Provide valve with all miscellaneous isolation valves pressure regulators as required.

D. Piping: Air piping is shown on Drawings with proposed routing and sizes shown. Supplier shall review Drawings and incorporate size and length of pipes into the system design. If pipe sizes need to be changed from sizes shown on Drawings, system supplier shall coordinate changes with General Contractor at no cost to Owner.

E. Air Backwash Manifold:
   1. Construct from Type 316 stainless steel piping.
   2. Threaded NPT connection to match piping diameter.
F. Instrumentation and Control:

1. General:
   a. Instrumentation and control in accordance with requirements of, and component qualities specified, in Section 40 99 90, Package Control Systems.
   b. Furnish all panels with the required logic and interfacing equipment, the final control elements, and all other hardware required for complete and operable systems. This includes all necessary engineering, furnishing, adjusting, testing, documenting, and starting up the air backwash screen cleaner system.
   c. The air backwash control systems shall control the air compressor, backwash control valve, and other equipment required to backwash the intake screen. Each cycle shall backwash the intake screen and then recharge the receiver with the compressor to ready the system for the next backwash cycle.

2. Panel shall include a LOCAL/OFF/REMOTE selector. Control for initiation of a backwash sequence for fish screen panel shall be provided for each of the following methods:
   a. Local:
      1) At an interval (adjustable to hours and minutes) to be set by Owner and adjusted as needed.
      2) Backwash cycle can be manually initiated by the local backwash cycle START pushbutton.
   b. Remote:
      1) Normally the system will be operated in this mode. Operator will adjust time of day settings from the Plant Control System.
      2) Plant Control System to be programmed by others to initiate backwash sequence at operator adjustable time(s) of day.

3. Screen Cleaner Control Panel:
   b. The panels shall include, but not be limited to, the following:
      1) Combination motor starter (NEMA Size 1 minimum) with overload protection per Section 26 24 19, Low-Voltage Motor Control.
      2) Control power transformer.
      3) Signals to actuate the compressor motor controls.
      4) Control Switches:
         a) Compressor TEST/OFF/AUTO.
         b) Control LOCAL/OFF/REMOTE.
         c) Backwash cycle START.
5) Pilot light indicating:
   a) Compressor power ON.
   b) Control Power ON.
   c) Compressor OVERLOAD.
   d) LOW Air Pressure.
   e) LOW Oil Level.
   f) Adequate Air Pressure.
   g) Cleaning Cycle in Progress.
   h) Backwash Valve Fully OPEN.
   i) Backwash Valve Fully CLOSED.

6) 0-minute to 3-minute adjustable time delay relay to delay, initiation of compressor start upon energizing control panel.

7) Fault Status of System: FAULT shall be result of the following.
   a) Low air pressure.
   b) Control power failure.
   c) Compressor overload.

c. External Interfaces:
   1) Discrete Output Signals to Plant Control System:
      a) FAULT alarm condition.
      b) Backwash Cycle in Progress.
      c) REMOTE status.

   2) Discrete Input Signals from Plant Control System: Start Backwash Cycle.

G. Compressed Air System:

1. General: Furnish air compressors as a complete system that includes compressor, receiver, motor, controls, and accessories. System shall be mounted on a self-contained skid with the screen cleaner control panel.

2. Air Backwash Compressed Air System:
   a. Compressor shall be oil-free design.
   b. Air backwash compressed air system shall be sized as appropriate for the provided screen.
   c. Air cooled.
   d. Automatic unloading during startup.
   e. Mount motor and compressor on common steel base attached to receiver.
   f. Compressor connected to motor by V-belt drive system with guard, and convenient method of belt tensioning.
   g. Equip with combination air intake filter silencer and discharge cushion chamber.
   h. Operating Discharge Pressure: 200 psig.
   i. Receiver Capacity: As determined by the Fish Screen manufacturer.
3. Motor:
   a. In accordance with NEMA MG 1.
   b. Type: Squirrel-cage.
   c. Enclosure: Drip-proof for indoor installation.
   d. Duty Cycle: Continuous.
   e. Horsepower: 5 (maximum).
   f. Rpm: Maximum 1,800.
   g. Volts: 460.
   h. Phase: Three.
   i. Frequency: 60-Hz.
   j. Service Factor: 1.15.
   k. Connected Load: Do not exceed motor nameplate horsepower rating for operating conditions.
   l. Additional Motor Requirements: See Section 26 20 00, Low-Voltage AC Induction Motors

4. Receiver:
   a. Vertical welded steel receiver bearing ASME code stamp and with inspection openings.
   c. Corrosion Allowance: 1/16 inch.
   d. Safety relief valve set for 200 psig.
   e. Pressure gauge with gauge cock.
   f. Automatic condensate drain valve with isolation valve.
   g. Manual blowdown valve located at low point in receiver.

2.03 FACTORY FINISHING

A. Exposed Metals: Manufacturer’s standard enamel finish.

B. Immersed Metals: NSF epoxy. Paint System No. 1, Section 09 90 00, Painting and Coating.

PART 3 EXECUTION

3.01 INSTALLATION

A. The equipment specified herein shall be located as indicated and installed in conformance with the manufacturer’s suggested method as approved. Contractor shall provide such additional incidental materials and labor as required for a complete and proper installation.

3.02 FIELD FINISHING

A. Factory Finished Equipment: Repair damaged surfaces using manufacturer’s paint touchup kit.
PHASE IV BEAVER CREEK WATER SUPPLY

B. Field Piping: As specified in Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. Prior to startup, all equipment shall be tested and inspected for proper alignment, quiet operation, proper connection, and satisfactory performance in conformance with Section 01 91 14, Equipment Testing and Facility Startup.

3.04 MANUFACTURER’S SERVICES

A. A manufacturer’s representative for the equipment specified herein shall be present at the jobsite for a minimum of 1 person-day (travel time excluded) to provide certification of the installation and startup assistance.

END OF SECTION
SECTION 44 44 13.01
CHEMICAL METERING PUMPS

EQUIPMENT AND COMPONENT NUMBER(S)

Intake Sodium Permanganate Feed Pump 1: I10P0041.
Intake Sodium Permanganate Feed Pump 2: I10P0042.
Intake Sodium Permanganate Field Panel: I10FP0040.
Intake Sodium Hydroxide Feed Pump: I10P0031
Intake Sodium Hydroxide Field Panel: I10FP0031
Aluminum Chlorohydrate Feed Pump 1: P20P0101.
Aluminum Chlorohydrate Feed Pump 2: P20P0102.
Aluminum Chlorohydrate Field Panel: P20FP0100.
Aluminum Chlorohydrate Feed Pump 3: P20P0103.
Aluminum Chlorohydrate Field Panel: P20FP0103.
Finished Water Sodium Hydroxide Feed Pump 1: P20P0131.
Finished Water Sodium Hydroxide Feed Pump 2: P20P0132.
Finished Water Sodium Hydroxide Field Panel: P20FP0130.
Sodium Hypochlorite Feed Pump 1: P20P0121.
Sodium Hypochlorite Feed Pump 2: P20P0122.
Sodium Hypochlorite Feed Pump 3: P20P0123.
Sodium Hypochlorite Field Panel: P20P0120.
Phosphoric Acid Feed Pump 1: P20P0141.
Phosphoric Acid Field Panel: P20FP0141.

PART 1   GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE): 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
2. Hydraulic Institute Standards.
3. National Electrical Manufacturer’s Association (NEMA): MG 1, Motors and Generators.

1.02 DEFINITIONS

A. Terminology pertaining to pumping unit performance and construction shall conform to the ratings and nomenclature of the Hydraulic Institute Standards.
1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Make, model, weight, and horsepower of each equipment assembly.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Performance data on pumps, including curves showing flow rate versus pump stroke setting (in percent) at specified maximum speed in strokes per minute and at minimum pump speed.
   d. Pump data sheet confirming pump capacity in gallons per hour and pressure in psig, required backpressure valve setting, pumped chemical characteristics, pipe connection sizes, stroke rate, materials, testing requirements, intermediate fluid type, and appurtenances to be provided with pumps.
   e. Detailed dimensional drawings for pump and driver, including mounting requirements and piping connection sizes and locations.
   f. Power and control wiring diagrams, including terminals and numbers.
   g. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.
   h. Manufacturer’s materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.
   i. Factory finish system.
   j. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Factory Functional and Performance Test Reports.
3. Special shipping, storage and protection, and handling instructions.
4. Manufacturer’s printed installation instructions.
5. Suggested spare parts list to maintain the equipment in service for a period of 1 year and 5 years. Include a list of special tools required for checking, testing, parts replacement, and maintenance with current price information.
6. List special tools, materials, and supplies furnished with equipment for use prior to and during startup and for future maintenance.
7. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
8. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.

1.04 EXTRA MATERIALS

A. Furnish for this set of pumps one complete set of any special tools required to dismantle pump.

PART 2 PRODUCTS

2.01 GENERAL

A. This specification covers the requirements for skid-mounted chemical feed pump package systems. The major system components include mounting skid, metering pump(s) with integral drive system, and the various appurtenances specified herein for a complete operable system, including check and pressure relief valves, pulsation dampener, pump connections, flushing and vent connections, inlet strainer, calibration column, pressure gauge, backpressure valve, and isolation ball valves.

B. Coordinate pump requirements with drive manufacturer and be responsible for pump and drive requirements.

C. Where adjustable speed drives are required, furnish a coordinated operating system complete with pump, drive, and speed controller.

2.02 SUPPLEMENTS

A. Some specific requirements are attached to this section as supplements.

2.03 METERING PUMP SKIDS AND ASSEMBLY

A. Metering pumps and appurtenances shall be delivered to the Site on pre-assembled skids. Refer to the Process and Instrumentation Diagram drawings (P&IDs) for limits of pump skid package system.

B. Base and Support: The skid base and support shall be formed of chemical resistant HDPE. All equipment shall be mounted inside the three-sided skid frame. Base shall include a shallow catch basin to contain minor spillage.

C. Assembly: Each skid shall be completely assembled, mounted, wired, tested and delivered to Site ready for installation. The skids shall be installed/anchored to pump pad or wall as shown on mechanical drawings. Units shall be laid out and constructed for ease of dismantling and repair.
D. All fasteners shall be stainless steel; pipe and tubing clamps shall be corrosion resistant material.

2.04 METERING PUMP

A. Manufacturer, Pump Series:

1. Prominent, Control.
2. “Or-equal.”

B. Pumps for low-capacity chemical feed shall be simplex, solenoid-driven, reciprocating, mechanically-actuated diaphragm type. Speed adjustment shall be by means of readily accessible controls on the pump face. The pump shall be programmable for proportional feed via 4 mA to 20 mA signal. A separate stroke length knob on front panel will adjust pump stroke with or without pump running. Maximum stroke rate shall be as specified in attached pump data sheet.

C. Alternatively, pumps shall be simplex, motor-driven, reciprocating, mechanically-actuated diaphragm type. Pumps shall include an integral motor, oil-lubricated gear reducer and a cam-spring drive mounted in aluminum housing.

D. Diaphragm shall be compression-molded Teflon or compression-molded Teflon composite with internal O-ring seal.

E. Liquid end shall be physically separated from drive unit by back plate with weep hole creating an air gap. Elastomer shaft wiper seal shall be provided to prevent migration of leakage to drive unit along shaft.

F. Pump shall include adjustable, spring-loaded internal pressure relief valve to protect pump against excessive hydraulic pressure.

2.05 CONTROLS

A. Each pump skid shall include field panel meeting applicable requirements of Section 40 99 90, Package Control Systems. Minimum requirements include:

1. Field Panel: One field panel for all pumps on the skid.
   a. NEMA Rating: 4X.
2. Indicating lights and controls for each pump:
   a. Speed indication in percent.
   b. HAND/OFF/REMOTE selector switch.
   c. Manual speed adjustment when operating in HAND mode.
   d. Pump ON indicating light.
   e. Drive FAIL indicating light.
f. Pump discharge pressure HIGH indicating light.
g. RESET pushbutton for reset of all fail and pressure conditions.

3. External interfaces for each pump:
   a. Analog Input: Accept 4 mA to 20 mA dc control signal for linear adjustment of pump speed from 0 percent to 100 percent when in REMOTE mode.
   b. Analog Output: Provide 4 mA to 20 mA dc signal for remote indication of pump speed, range 0 percent to 100 percent.
   c. Discrete Inputs:
      1) Dry contact from package supplied discharge pressure switch to stop pump until RESET is pressed.
      2) Dry contact RUN command from plant control system to operate pump when in REMOTE mode.
   d. Discrete Outputs:
      1) Dry Contacts Rated 5A at 120V ac:
         a) Pump ON status.
         b) REMOTE mode status.
         c) Drive FAIL status.
         d) Pump discharge pressure HIGH.

B. Power: System shall operate from one circuit fed to the skid-mounted field panel. Voltage and phase as noted in the Pump Data Sheets. Distribute power on the skid from the field panel to each pump, with a separate circuit breaker for each pump. Provide separate lockable electrical disconnecting means for each pump.

2.06 PULSATION DAMPENERS

A. Single-diaphragm type mounted on discharge piping as shown for pneumatic-hydraulic pulsation dampening. Size for pump stroke volume. Body material shall be PVC and diaphragm material shall be PTFE.

B. Air charging valve and pressure gauge.

2.07 INSTRUMENTATION

A. Pressure Diaphragm Seal:
   1. Isolate each pressure gauge and pressure switch from chemicals with seal.
   2. Provide individual seal for each gauge and each pressure switch.
   3. Manufacturer and Product: Ashcroft; Model 50.
   4. Quantity: Two per pump.
B. Pressure Gauge:
   1. Pressure gauges for pump discharge pressure indication.
   3. Quantity: One per pump.

C. Pressure Switch:
   1. Pressure switch for pump discharge pressure alarm and protection.
   2. Manufacturer and Product: Ashcroft; Model B424.
   3. Provide switch model with a setpoint that is within 40 percent to 60 percent span of the switch. The switch shall be set above the maximum operating pressure, but below the relief valve pressure.
   4. Quantity: One per pump.

D. Provide stainless steel tags labels for each instrument.

2.08 VALVES

A. See Section 40 27 02, Process Valves and Operators.

B. Adjustable diaphragm backpressure sustaining type installed on pump discharge as shown on Drawings and set as stated in the supplemental data sheets.

C. Adjustable pressure relief type installed on pump discharge as shown on Drawings and set as stated in the supplemental data sheets.

2.09 PUMP OUTPUT CONTROL

A. Manual Stroke Adjustment: Provide manual stroke length adjustment through adjustment knob on unit that provides adjustment accuracy of 1 percent. Adjustment shall be self-locking, and shall be operable whether or not pump is running.

B. Adjustable Speed (Stroke Frequency) Adjustment: Provide adjustable speed operation of pump.

2.10 ACCESSORIES

A. Equipment Identification Plate: 16-gauge stainless steel with 1/4-inch die-stamped equipment tag number securely mounted in a readily visible location.

B. Lifting Lugs: Equipment weighing over 100 pounds.
C. Anchor Bolts: Type 316 stainless steel sized by equipment manufacturer and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

D. Gauge Connections: Tapped and plugged suction and discharge gauge connections on piping headers adjacent to pumps.

E. Screens or Guards: Mesh size of less than 0.5 inch, exposed rotating shafts, rotors, couplings, pulley, wheel, bolts, chains, or similar components. Where guards/screens are over grease fittings, couplings, or other items requiring maintenance, provide a means for ready access.

F. Calibrated Cylinder: Graduated in 1-milliliter increments, constructed of clear polypropylene and PVC with ball type shutoff valve. Provide calibration column as shown on Drawings and as stated in supplemental data sheets.

2.11 FACTORY FINISHING
A. Manufacturer’s standard.

2.12 SOURCE QUALITY CONTROL
A. Factory Inspections: Inspect control panels for required construction, electrical connection, and intended function.

B. Factory Tests and Adjustments: Test all equipment and control panels actually furnished.

C. Factory Test Report: Include test data sheets.

D. Functional Test: Perform manufacturer’s standard motor test on equipment.

PART 3 EXECUTION

3.01 INSTALLATION
A. Install in accordance with manufacturer’s printed instructions.

B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

3.02 FIELD FINISHING
A. Equipment as specified in Section 09 90 00, Painting and Coating.
3.03 FIELD QUALITY CONTROL

A. Conduct tests on each pump.

B. Functional Test:
   1. Alignment: Test complete assemblies for correct rotation, proper alignment and connection, and quiet operation.

C. Performance Test:
   1. Perform under actual or approved simulated operating conditions.
   2. Test for a continuous 3-hour period without malfunction.

3.04 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative: Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   1. 1 person-day for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation, and for training of Owner’s personnel.

B. See Section 01 43 33, Manufacturers’ Field Services, and Section 01 91 14, Equipment Testing and Facility Startup.

3.05 SUPPLEMENTS

A. Supplements listed below, following “End of Section,” are part of this Specification.
   1. Sodium Permanganate Feed Pumps 1 and 2 Data Sheet.
   2. Sodium Hydroxide Feed Pump 1 Data Sheet.
   3. Aluminum Chlorohydrate Feed Pumps 1 - 3 Data Sheet.
   4. Sodium Hydroxide Feed Pumps 1 and 2 Data Sheet.
   5. Sodium Hypochlorite Feed Pumps 1 - 3 Data Sheet.
   6. Phosphoric Acid Feed Pump 1 Data Sheet.

END OF SECTION
SODIUM PERMANGANATE FEED PUMPS 1 AND 2 DATA SHEET

Tag Numbers: I10P0041 and I10P0042

Pump Name: Intake Sodium Permanganate Feed Pumps 1 and 2

Manufacturer and Model Number: (1) ProMinent Gamma/X Series
(2) __________________________

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 20% Sodium Permanganate (S.G. 1.17)

Pumping Temperature (Fahrenheit): Normal: 70 Max 100 Min 50

Liquid pH: 5.0-8.0

Abrasive (Y/N) ______ Possible Scale Buildup (Y/N): ______

Suction Pressure (psig): Minimum See Comments

Altitude (ft msl): 223 Area Classification: _____ Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 0.2 Minimum: 0.01

Maximum Discharge Pressure (psig): 130

Internal Bypass Valve Setting (psig): ________________

Relief Valve Setting (psig/as recommended): ______

Back Pressure Valve Setting (psig/as recommended): __________

Max. Stroke Rate (spm): Mfr. (1) ________________ Mfr. (2) ________________

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) ______ Other ________________

Wet End Material: PVDF ________ Tubular Diaphragm Housing Material: ______

Check Valve Material: ________ Configuration(Single/Double): ________

Diaphragm Material: PTFE ________ Primary: ____ Tubular: __________

Calibration Cylinder: Quantity: 1 ______ Material: PVDF/Glass Units: mL Capacity: 100 mL

Diaphragm Actuation Type: Mechanical X, Solenoid-driven ______ Hydraulic ______

Stroke Position Adjustment: Manual X ______ Automatic __________

Pump Speed Control: Constant ______ Variable X
DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120V ac Phase: 1ph Synchronous Speed (rpm) _____

Service Factor: _______

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

TESTING

Pump Tests: Factory Functional (Y/N) _____ Factory Performance (Y/N) _____
Field Functional (Y/N) _____ Field Performance (Y/N) _____
Motor Test: Short Commercial (Y/N) _____ Other _____

REMARKS: Suction lift from 55-gallon drum.
Tag Numbers: I10P0031
Pump Name: Intake Sodium Hydroxide Feed Pump 1
Manufacturer and Model Number: (1) ProMinent Gamma X Series
(2)______________________________

SERVICE CONDITIONS
Liquid Pumped (Material and Percent): 25% Sodium Hydroxide (S.G. 1.25)
Pumping Temperature (Fahrenheit): Normal: 70 Max 100 Min 40
Liquid pH: 14
Abrasive (Y/N) _______ Possible Scale Buildup (Y/N): _______
Suction Pressure (psig): Minimum See Comments
Altitude (ft msl): 223 Area Classification: _____ Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS
Capacity (US gpm): Maximum: 1.0 ______ Minimum: 0.05_______
Maximum Discharge Pressure (psig): 130__________
Internal Bypass Valve Setting (psig): _________________
Relief Valve Setting (psig/as recommended): ______
Back Pressure Valve Setting (psig/as recommended): _________
Max. Stroke Rate (spm): Mfr. (1) _________________ Mfr. (2) __________

DESIGN AND MATERIALS
Pump Type: Single Diaphragm (Y/N) Y__________
Tubular (double) Diaphragm (Y/N) ______ Other _________________
Wet End Material: PVDF__________ Tubular Diaphragm Housing Material: ______
Check Valve Material: _______ Configuration(Single/Double): _______
Diaphragm Material: PTFE ______ Primary: ___ Tubular: _______
Calibration Cylinder: Quantity: 1____ Material: PVC Units: mL Capacity: 250 mL
Diaphragm Actuation Type: Mechanical X solenoid-driven___ Hydraulic _______
Stroke Position Adjustment: Manual X_______ Automatic ________________
Pump Speed Control: Constant __________ Variable X________________
**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: 120 V ac  Voltage: 120 V ac  Phase: 1 ph  Synchronous Speed (rpm) 

Service Factor: 

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP ☐ EXP ☐ ODP ☐ TEFC ☐ CISD-TEFC ☐ TENV ☐ WPI ☐ WPII ☐ SUBM ☐

**TESTING**

Pump Tests: Factory Functional (Y/N) Y  Factory Performance (Y/N) N

   Field Functional (Y/N) Y  Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) ☐  Other ☐

REMARKS: Suction lift from 55-gallon drum.
ALUMINUM CHLOROHYDRATE FEED PUMPS 1 – 3 DATA SHEET

Tag Numbers: P20P0101, P20P0102, and P20P0103

Pump Name: Aluminum Chlorohydrate Feed Pumps 1 - 3

Manufacturer and Model Number: (1) ProMinent Gamma X Series
(2) ________________________________

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 50% Aluminum Chlorohydrate (S.G. 1.33)
Pumping Temperature (Fahrenheit): Normal: 70 Max 100 Min 40
Liquid pH: 5.5
Abrasive (Y/N) _______ Possible Scale Buildup (Y/N): _______
Suction Pressure (psig): Minimum See Comments
Altitude (ft msl): 223 Area Classification: _____
Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 2.0 Minimum: 0.1
Maximum Discharge Pressure (psig): 50
Internal Bypass Valve Setting (psig): ______________________
Relief Valve Setting (psig/as recommended): As recommended
Back Pressure Valve Setting (psig/as recommended): As recommended
Max. Stroke Rate (spm): Mfr. (1) __________________ Mfr. (2) __________

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y
Tubular (double) Diaphragm (Y/N) N Other _______________
Wet End Material: PVDF _______ Tubular Diaphragm Housing Material: ______
Check Valve Material: Clear PVC ______ Configuration(Single/Double): Single
Diaphragm Material: PTFE _______ Primary: X ______ Tubular: ______
Calibration Cylinder: Quantity: 1 Material: Clear PVC Units: mL
Capacity: 250 ______________
Diaphragm Actuation Type: Mechanical X ______ Hydraulic _____________
Stroke Position Adjustment: Manual X ______ Automatic ______________
Pump Speed Control: Constant ______ Variable X _______________
PHASE IV BEAVER CREEK WATER SUPPLY

DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120V ac Phase: 1 Synchronous Speed (rpm)_____
Service Factor: ______
Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

TESTING

Field Functional (Y/N): Y_____ Field Performance (Y/N): Y_____
Motor Test: Short Commercial (Y/N): Y______ Other _____

REMARKS: Suction lift out of 350-gallon tote.
SODIUM HYDROXIDE FEED PUMPS 1 AND 2 DATA SHEET

Tag Numbers: P20P0131 and P20P0132

Pump Name: Finished Water Sodium Hydroxide Feed Pumps 1 - 2

Manufacturer and Model Number: (1) ProMinent Gamma X Series
(2) ____________________________

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 25% Sodium Hydroxide (S.G. 1.25)
Pumping Temperature (Fahrenheit): Normal: 70 Max 100 Min 40
Liquid pH: 14
Abrasive (Y/N) _______ Possible Scale Buildup (Y/N): _______
Suction Pressure (psig): Minimum ______
Altitude (ft msl): 223 Area Classification: ______ Location (indoor/outdoor): Indoors

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Maximum: 1.0 Minimum: 0.1
Maximum Discharge Pressure (psig): 50
Internal Bypass Valve Setting (psig): _________________
Relief Valve Setting (psig/as recommended): ______
Back Pressure Valve Setting (psig/as recommended): _______
Max. Stroke Rate (spm): Mfr. (1) _________________ Mfr. (2) _____________

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y
Tubular (double) Diaphragm (Y/N) ______ Other ________________
Wet End Material: PVDF _______ Tubular Diaphragm Housing Material: ______
Check Valve Material: ______ Configuration(Single/Double): _______
Diaphragm Material: PTFE _______ Primary: ______ Tubular: _______
Calibration Cylinder: Quantity: ______ Material: _____ Units: _____ Capacity: _____
Diaphragm Actuation Type: Mechanical X solenoid-driven Hydraulic ______
Stroke Position Adjustment: Manual X ______ Automatic _______
Pump Speed Control: Constant ________ Variable X ________
DRIVE MOTOR (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: Voltage: 120V ac Phase: 1 ph Synchronous Speed (rpm) __________

Service Factor: ______

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____ TENV _____ WPI _____ WPII _____ SUBM _____

TESTING

Pump Tests: Factory Functional (Y/N) Y Factory Performance (Y/N) N

Field Functional (Y/N) Y Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) _____ Other _____

REMARKS

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________
SODIUM HYPOCHLORITE FEED PUMPS 1 - 3 DATA SHEET

Tag Numbers: P20P0121, P20P0122, and P20P0123

Pump Name: Sodium Hypochlorite Feed Pumps 1 - 3

Manufacturer and Model Number: (1) ProMinent Sigma/2

(2) _______________________________________

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 0.8% Sodium Hypochlorite (S.G. 1.0)

Pumping Temperature (Fahrenheit): Normal: 70 Max 100 Min 40

Liquid pH: 9

Abrasive (Y/N) N Possible Scale Buildup (Y/N): N

Suction Pressure (psig): Minimum 0.4

Altitude (ft msl): 223 Area Classification: Location (indoor/outdoor): Indoor

PERFORMANCE REQUIREMENTS

Capacity (US gph): Maximum: 35 Minimum: 4

Maximum Discharge Pressure (psig): 50

Internal Bypass Valve Setting (psig): ________________

Relief Valve Setting (psig/as recommended): ______

Back Pressure Valve Setting (psig/as recommended): ______

Max. Stroke Rate (spm): Mfr. (1) ________________ Mfr. (2) ________________

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N) N Other ________________

Wet End Material: PVC or PVDF Tubular Diaphragm Housing Material: ______

Check Valve Material: Clear PVC Configuration(Single/Double): Single

Diaphragm Material: PTFE Primary: X Tubular: ______

Calibration Cylinder: Quantity: 1 Material: PVC Units: mL Capacity: 2,000

Diaphragm Actuation Type: Mechanical X Hydraulic ________________

Stroke Position Adjustment: Manual X Automatic ________________

Pump Speed Control: Constant Variable X
**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors)

- **Horsepower:** _____  
- **Voltage:** 120V ac  
- **Phase:** 1  
- **Synchronous Speed (rpm):** _____

**Service Factor:** ______

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

**Enclosure:**  
- DIP _____  
- EXP _____  
- ODP _____  
- TEFC _____  
- CISD-TEFC _____  
- TENV _____  
- WPI _____  
- WPII _____  
- SUBM _____

Adjustable Speed Drive, See Section 26 29 23, Low-Voltage Adjustable Frequency Drive System.

**TESTING**

- **Pump Tests:**  
  - Factory Functional (Y/N) Y  
  - Factory Performance (Y/N) N  
  - Field Functional (Y/N) Y  
  - Field Performance (Y/N) Y  

- **Motor Test:**  
  - Short Commercial (Y/N) _____  
  - Other _____

**REMARKS**

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
PHOSPHORIC ACID FEED PUMP 1 DATA SHEET

Tag Numbers: P20P0141

Pump Name: Phosphoric Acid Feed Pump 1

Manufacturer and Model Number: (1) ProMinent Gamma X Series

(2) ______________________________________________________________________

SERVICE CONDITIONS

Liquid Pumped (Material and Percent): 75% Phosphoric Acid (S.G. 1.685)

Pumping Temperature (Fahrenheit): Normal: 70   Max 100   Min 40

Liquid pH: <1

Abrasive (Y/N) ______  Possible Scale Buildup (Y/N): ______

Suction Pressure (psig): Minimum See Comments

Altitude (ft msl): 223  Area Classification: _____ Location (indoor/outdoor): Indoors

PERFORMANCE REQUIREMENTS

Capacity (US gpm): Maximum: 0.2    Minimum: 0.01

Maximum Discharge Pressure (psig): 50

Internal Bypass Valve Setting (psig): _________________

Relief Valve Setting (psig/as recommended): ______

Back Pressure Valve Setting (psig/as recommended): ______

Max. Stroke Rate (spm): Mfr. (1) _________________ Mfr. (2) _______________

DESIGN AND MATERIALS

Pump Type: Single Diaphragm (Y/N) Y

Tubular (double) Diaphragm (Y/N)       Other _________________

Wet End Material:  PVDF   Tubular Diaphragm Housing Material: ______

Check Valve Material: PVDF w/ceramic ball ______ Configuration(Single/Double):

_____

Diaphragm Material: PTFE ______ Primary: _____ Tubular: ______

Calibration Cylinder: Quantity: 1 _____ Material:  PVC Units: mL

Capacity: 100 mL _________________

Diaphragm Actuation Type: Mechanical X solenoid-driven  Hydraulic ______

Stroke Position Adjustment: Manual X _____ Automatic _________________

Pump Speed Control:  Constant _________________ Variable  X _______________
**DRIVE MOTOR** (See Section 26 20 00, Low-Voltage AC Induction Motors)

Horsepower: _____ Voltage: 120V ac Phase: 1 ph Synchronous Speed (rpm) _____

Service Factor: ______

Motor nameplate horsepower shall not be exceeded at any head-capacity point on pump curve.

Enclosure: DIP _____ EXP _____ ODP _____ TEFC _____ CISD-TEFC _____
TENV _____ WPI _____ WPII _____ SUBM _____

**TESTING**

Pump Tests: Factory Functional (Y/N) Y  Factory Performance (Y/N) N

Field Functional (Y/N) Y  Field Performance (Y/N) Y

Motor Test: Short Commercial (Y/N) _____  Other _____

**REMARKS:** Suction lift from 55-gallon drum.
PHASE IV BEAVER CREEK WATER SUPPLY

SECTION 44 44 13.02
SODIUM HYPOCHLORITE GENERATION SYSTEM

EQUIPMENT AND COMPONENT NUMBER(S)

Water Softener: P20M0112.
Brine Saturator Tank: P20T0113.
Brine Transfer Pump: P20M0114.
Sodium Hypochlorite Generator: P20M0115.
Transformer/Rectifier: P20M0116.
Sodium Hypochlorite Tank: P20T0117.
Sodium Hypochlorite Tank Vent Airflow Switch: 20PFE/FSL0117.
Hydrogen Dilution Blower 1: P20M0118.
Hydrogen Dilution Blower 2: P20M0119.
Refer to P&ID Drawing 08-N-021 for additional instrumentation.

PART 1 GENERAL

1.01 GENERAL

A. This specification covers the onsite sodium hypochlorite generation system including the following major components:

1. Skid-mounted sodium hypochlorite generation system to include electrolytic cells, transformer/rectifier, brine pump, water heater, control panel, and appurtenances.
2. Salt storage/brine saturator tank (outdoor installation).
3. Sodium hypochlorite storage tank (indoor installation).
4. Water softener system.
5. Cart-mounted electrolytic cell acid cleaning system.
6. Hydrogen dilution blowers and monitor system.

1.02 REFERENCES

A. The following is a list of standards with may be referenced in this section:

1. Air Movement and Control Association (AMCA).
3. ASTM International (ASTM):

4. Institute of Electrical and Electronics Engineers (IEEE): 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
5. National Electric Manufacturer’s Association (NEMA).

1.03 DEFINITIONS

A. FRP: Fiberglass reinforced plastic.
B. HDPE: High-density polyethylene.
C. ISC: Instantaneous short circuit.
D. OIT: Operator interface terminal.
E. PLC: Programmable logic controller.
F. SCR: Silicon controlled rectifier.
G. System Supplier: Entity responsible for furnishing equipment specified in this section as a complete operable system and for providing specified manufacturer’s services.
H. THD: Total harmonic distortion.
I. XLHDPE: Cross-linked high-density polyethylene.

1.04 SUBMITTALS

A. Action Submittals:
   1. List of proposed system components; bill of materials.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Detailed dimensional drawings for equipment, including mounting requirements, and piping connection sizes and locations.
4. Piping drawings with identification of materials, including pipe, fittings, valves, specialties, hangers, supports, insulation, heat tracing and labeling.
5. Performance data on blowers and pumps.
6. Manufacturer’s materials compatibility information, confirming compatibility of wetted parts with specified pumped chemicals.
7. External mechanical utility requirements, including water supply and drain for each component or compressed air. Specify acceptable range of utility pressure and temperature for proper system operation.
8. Manufacturer, model, weight, and rating(s) of each equipment assembly.
9. Complete motor nameplate data as defined by NEMA, motor manufacturer, and motor modifications needed.
10. Schematic and wiring diagrams showing power, control, and instrumentation circuits, wiring identification, and field interconnection wiring between control panel and other components.
11. Electrical power supply requirements for rectifiers, control panel, and auxiliary electrical devices.
12. Rectifier harmonics spectrum; harmonic calculations for transformer/rectifier unit in accordance with IEEE 519 and as specified.
13. Process instrumentation and flow diagrams (P&IDs) showing location of valves, instruments, and auxiliary equipment.
14. Functional description of internal and external instrumentation and controls including list of parameters monitored, controlled, or alarmed, at both system control panel and remotely.
15. Control panel arrangement drawings showing outline dimensions and front-of-door and internal backplane device location.
17. Factory finish system.
19. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Cell Performance Calculations: Data shall include electrode area measurements, and current flows. Electrode service factor shall be expressed in amperes per square inch of electrode surface.
2. Special shipping, storage and protection, and handling instructions.
3. Manufacturer’s printed installation instructions.
4. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
5. NSF 61 Certification for all wetted components.
6. PLC and OIT program listings in hard copy and electronic media formats. Documentation shall include complete data mapping of process parameters, and status and alarm variables required to provide for remote monitoring.
7. Certified factory inspection and test reports on manufacturer’s standard forms.
9. Field test reports for each functional and performance test of equipment.
10. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
11. Suggested spare parts list to maintain the equipment in service for periods of 1 year and 5 years, with current pricing. Include a list of tools required for checking, testing, parts replacement, and maintenance, and specify if any of these are furnished with the equipment.
12. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 43 33, Manufacturers’ Field Services.
13. Executed Special Guarantee.

1.05 QUALITY ASSURANCE

A. Qualifications: System Supplier shall have at least 5 years’ experience in furnishing similar equipment of similar capacity and service capability to equipment specified herein.

1.06 SPECIAL GUARANTEE

A. Provide manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at the option of Owner, removal and replacement of anode plates found to be defective or failing to perform within the water, power, and salt consumption limits stated herein during a period of 7 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective equipment shall be as specified in the General Conditions. The manufacturer’s responsibility for this extended warranty shall be:

1. Full anode replacement cost for the first 2 years following Substantial Completion.
2. Anode replacement cost on a prorated basis from the 3rd year to 7th year of operation.
1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts, special tools, and materials:

1. One complete set of fuses for control panel.
2. One complete set of fuses for transformer/rectifier.
3. One electrolytic cell level and temperature switch assembly, or one level and one temperature switch if individual components.
4. One dilution water solenoid valve.
5. Brine Pump: One set of manufacturer recommended spare parts.
6. One airflow or differential-pressure switch assembly.
7. One complete set of special tools required to service equipment provided.
8. Provide greases and lubricants for 1 year of continuous operation for each system.

B. Pack spare parts in sturdy containers with clear indelible identification markings and store in a dry, warm location until transferred to Owner.

C. Delivery: In accordance with Section 01 61 00, Common Product Requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Materials, equipment, and accessories specified in this section shall be products of:

1. Process Solutions, Inc., Campbell, CA; Microclor.
2. Severn Trent Services, Torrance, CA; ClorTec.
3. Evoqua Water Technologies, Pittsburgh, PA; OSEC.

2.02 GENERAL

A. System shall be complete and, except for field installation and interconnection of components and assemblies, ready for operation.

B. OSHG System Assembly and Interconnection: Provide as a skid-mounted assembly with various separate field-mounted devices or equipment, as specified.

1. The following equipment shall be factory-mounted on a common skid:
   a. Control panel, transformer/rectifier, electrolytic cell, brine proportioning pump, water heater or heat exchanger,
interconnecting piping, tubing, valves, instrumentation, and control and power wiring. Optionally, the water softener may be skid-mounted.

b. Skid shall have external connections or terminal blocks for: system power and control wiring, external control, monitoring and alarm circuit wiring, domestic water supply (in), hypochlorite (out), process brine solution from brine tank (in), hydrogen gas vent (out), drain (out), and acid cleaning solution (in).

2. The following devices and equipment shall be furnished loose for field installation and interconnection with other system components:
   a. Cartridge filters, water softener, hydrogen gas detector, air flow sensors, hydrogen dilution blowers, brine saturator tank, and sodium hypochlorite tank. Optionally, the water softener may be skid-mounted.

2.03 SERVICE CONDITIONS

A. Site Conditions:

   1. Design Criteria: See Section 01 61 00, Common Product Requirements.
   2. Location: Indoor.
   4. Water Supply Pressure (prior to regulator or booster pump): Approximately 40 psi to 60 psi.
   5. Water Supply Temperature: 40 degrees F to 65 degrees F.
   6. Water Hardness: Less than 50 mg/L as CaCO₃.
   7. Water Iron Level: 0.1 mg/L to 0.3 mg/L.
   8. Water Manganese Level: 0.01 mg/L to 0.05 mg/L.
   9. Sodium Hypochlorite Injection Point Pressure: 20 psi to 50 psi.

B. Feed Points:

   1. Under normal conditions, onsite generated hypochlo-rite (0.8 percent) will be conveyed to sodium hypochlorite storage tanks where the solution will be stored and pumped to existing injection points.
   2. Under emergency conditions, the system shall allow commercially available sodium hypochlorite (10 percent to 15 percent) to be stored in lieu of the 0.8 percent sodium hypochlorite.

2.04 SODIUM HYPOCHLORITE GENERATION SYSTEM

A. General:

   1. Provide system capable of producing 60 pounds per day available chlorine.
2. Generate aqueous solution of a nominal concentration of 0.8 percent, plus or minus 0.05 percent, by weight sodium hypochlorite expressed as available chlorine.
3. Use 99.7 percent pure dry weight solar salt containing no organic binders, flow control agents, or resin cleaning material.
4. Process shall operate on a batch basis, providing consistent hypochlorite concentrations and greatest efficiencies.
5. System shall have no waste products associated with system’s use other than hydrogen gas which shall vent to the atmosphere, and water softener regeneration brine which shall be routed to a drain. Hydrogen Dilution blowers will be used to purge residual hydrogen from OSHG system and storage tanks, and dilute the hydrogen concentration 100 to 1 or below 25 percent of the Lower Explosion Limit (LEL).
6. Sodium hypochlorite generator’s utility requirements shall not exceed the following per pound of available chlorine equivalent produced:
   a. Electrical Energy: 2.0 kilowatt-hours (kWh) (ac).
   b. Water: 15 gallons.
   c. Salt: 3 pounds.
7. Skid-mounted Generation System:
   a. Those portions of the system specified herein to be skid-mounted, or shown on Drawings to be mounted on a skid, shall be factory wired, plumbed, and assembled on a common skid and tested prior to shipment as a complete functioning system.
   b. Skid frame shall be carbon steel, coated as specified under Paragraph Factory Finish.
8. Acid Cleaning Provisions: Provide a portable cart-mounted acid feed system with a tank, 120-volt single-phase feed pump with cord and plug, ON/OFF switch, hoses and quick couplings for connecting to generation system piping, and cart with wheels and a handle.

B. Sample Points: Provide the following valved sample points as a minimum:

1. Brine solution.
2. Sodium hypochlorite product.
3. Softened water product.
4. Provide permanent piping and supports from sample point valve to convenient sample collection point, suitable for obtaining a sample without spill or dripping onto equipment or skid.

C. Brine Flow Control: Provide with throttling valves and rotameters, or other flow measuring devices, to dilute concentrated brine with softened water to produce a 3 percent solution to be delivered to electrolytic cell.
D. Electrolytic Cell:

1. For electrolytic cell bodies that are constructed with transparent materials of constructions to facilitate visual inspection, the electrolytic cell bodies shall be constructed of clear acrylic materials, allowing for front and rear visual inspection of the electrodes from all angles.
2. Each cell loop shall also incorporate an optical or float-type level sensor to preclude any possibility of exposing an active electrode surface.
3. Construction allowing for electrodes to be removed as a single assembly.
4. Joining of cell materials shall be by solvent welding or mechanical compression. Thermal welding shall not be allowed.
5. Electrodes:
   a. Titanium with anodes coated with a mixed metal oxide catalytic coating for electrical efficiency and maximum longevity.
   b. Vertically oriented, solid flat plate construction to maximize high velocity gas lift between electrodes and minimize scaling.
   c. Expanded metal electrodes shall not be allowed.
6. Cell Current Density: 1.2 amps per square inch maximum.
7. Cells shall operate at low voltage (115V or less) to minimize electrical hazard to operators.
8. Cells shall be factory pressure-tested to 55 psi, for a period of 15 minutes, prior to final assembly and shipment.
9. Bolting hardware shall be titanium.

E. Hydrogen Safety:

1. The cells shall operate at atmospheric pressure and discharge the hydrogen at each cell compartment.
2. The generator shall be designed to allow passive venting of the waste hydrogen produced from each cell or cell compartment to eliminate the possibility of inadvertently pressurizing the cell and causing failure.
3. System shall release hydrogen from each cell pack. Waste hydrogen shall not be allowed to flow from one cell to the next.

F. Transformer/rectifier Unit (P20M0116):

1. Units shall provide dc power to each electrolytic cell.
2. Enclosure:
   a. NEMA Type 1, with provision for anchoring to floor or to generator system skid.
   b. The transformer rectifier shall house a 4 mA dc to 20 mA dc current transducer and NEMA 4X digital display of amperage.
3. Transformer:
   a. Suitable for full-wave rectifier connection.
   b. Rated to operate at elevation and ambient temperature specified.
   c. Frame mounted in a NEMA 4X enclosure, air cooled; with Class H insulation and 80 degrees C temperature rise.

4. Output and kVA Rating:
   a. As required for operation of sodium hypochlorite generation system.
   b. Equipped for termination of the required number of conductors with compression spade lugs at each dc connection.


6. Cooling: Aluminum heat sink with 120V ac cooling fan.

7. Overall Rectifier System Efficiency: 97 percent minimum at rated output.

8. Power Supply:
   a. 208V ac, three-phase, 60-Hz, with maximum load of 50 amps.
   b. Equip with built-in dc-volt and amp display, emergency shut-off switch, and disconnect switch.

9. Disconnect:
   a. Nonfused disconnect switch on each separate power supply to simultaneously open incoming ungrounded circuit conductors.
   b. Operating handle accessible through enclosure door. Incorporate interlock to prevent opening door when switch is in ON position. Provide pad-lockable operating mechanism handle.

10. Metering:
    a. Provide metering of output voltage and output current.
    b. Sensing devices and displays shall have overall accuracy of 0.5 percent or better.

2.05 STORAGE TANKS

A. Salt Storage/Brine Saturator Tank (P20T0113):

1. In accordance with Section 43 40 02, Fiberglass Reinforced Plastic Tank.
2. Provide covered, insulated with heat-tracing, FRP salt storage/brine saturator tank capable of holding 22 tons of salt.
3. Tank shall be equipped with a long-radius stainless steel salt fill tube (pneumatic filling) with dust collector, top and side manways, level controls, salt level indication and transmitter, and quartz rock filter bed.
4. Tank shall be approximately 8 feet in diameter by 15 feet tall.
5. Provide direct sensing level transmitter as specified in Article Instruments.
6. Provide solids level transmitter as specified in paragraph Instruments.
7. Salt storage/bine saturator tank shall be Plas-Tanks Industries, Inc. Bryneer™ Model 8-15, “or-equal.”

B. Sodium Hypochlorite Storage Tank (P20T0117):
   1. In accordance with Section 43 40 02, Fiberglass Reinforced Plastic Tank.
   2. Provide a 4,600-gallon covered FRP sodium hypochlorite storage.
   3. Tank shall be approximately 10 feet in diameter with a sidewall shell height of 8 feet tall.
   4. Tank cover shall have an 18-inch minimum diameter access port.
   5. Provide ultrasonic level transmitter on tank.
      a. Transmitter shall provide 4 mA to 20 mA dc output signal to control panel for tank level indication, START/STOP batch operation, and HIGH and LOW level alarm initiation.
   6. Provide airflow or differential-pressure switch, as specified herein, on each tank purge air outlet pipe for air flow failure alarm initiation.

2.06 PUMPS

A. Brine Transfer Pump (P20M0114):
   1. Positive Displacement Gear Pump with Adjustable Frequency Drive:
      a. Drive shall be capable of Ethernet/IP communications.
      b. Drive shall be capable of continuous operation of lad capacity throughout speed range of 0 percent to 120 percent of rated speed.
      c. Drive shall accept a 4 mA to 20 mA SPEED COMMAND and 5A rated discrete RUN contact.
      d. Drive shall output a 5A rated RUNNING status to PLC.
      e. Drive board shall be conformally coated to prevent additional corrosion.
   2. Alternatively, brine transfer pump may be a diaphragm type that delivers constant dosing to the electrolyzer.
   3. Wetted parts shall be constructed of polypropylene, glass-filled polyester, Hypalon elastomers, or Teflon.
   4. Electric motor driven, with power and control supplied from system control panel.

2.07 WATER SOFTENER (P20M0112)

A. Water softener shall use brine from brine saturator tank for regeneration.
B. Features:

1. Dual tank, continuously operational (one tank in operation while other tank regenerates).
2. Capable of automatically regenerating without use of electric timers or gear motors.
3. Regeneration cycles shall be flow dependent only.
4. Sized to regenerate not more than once every 8 hours based on system operating continuously at rated capacity.
5. Rated for 125 psig maximum working pressure and tested at 300 psig.
6. NSF 61 approved.

C. Valving:

1. Provide isolation valves on inlet and outlet for water softener.
2. Provide bypass valve around water softener.

D. Manufacturer: Kinetico with automatic switchover and bypass valve assembly.

2.08 WATER HEATER (NO ASSIGNED TAG #)

A. The water heater or heat exchanger is integral to the Sodium Hypochlorite Generation skid and is not shown on the P&ID Drawing 08-N-021. Water heater shall increase supply water temperature to a minimum of 60 degrees F.

B. Water heater shall be as specified in Section 22 30 00, Plumbing Equipment.

C. Heat Recovery Heat Exchanger:

1. Shall use sodium hypochlorite leaving generator to preheat dilution water entering generator.
2. Type:
   a. Brazed Plate: Constructed of titanium.
5. Provide isolation valves at inlet and outlet for heat exchanger.
6. Provide bypass valve around heat exchanger with flush and drain valves.

2.09 HYDROGEN DILUTION BLOWERS (P20M0118, P20M0119)

A. Provide two hydrogen dilution blowers (one duty, one standby).
B. Features:

1. Each blower sized to reduce concentration of hydrogen gas in storage tank to less than 1 percent in air on a volumetric basis; 25 percent of lower explosive limit (LEL).
2. Blower Wheel and Housing: Aluminum or FRP.
3. AMCA Type B spark resistant construction.
4. Provide flanged inlet and outlet connections, scroll drain port with plug, and belt guard if belt driven.
5. Provide backdraft damper or check valve in blower discharge.
6. Power Supply: 240V ac, three-phase, 60-Hz supplied from motor controller located in system control panel.
7. Monitor blower operation and coordinate with operation of air flow or differential pressure switch(es) to provide safety interlocks, and alarm indication. Monitoring functions shall be powered, controlled, and monitored by system control panel.

C. Manufacturers:

1. New York Blower Co.
2. Cincinnati Fan.

D. Minimum passive venting capability shall be 4 square inches for every 100 pounds of chlorine production.

2.10 CARTRIDGE FILTER

A. Features:

1. In-line orientation.
2. Reinforced clear PVC housing.
3. Disposable cartridge insert.
4. Rated for particle removal at design flow rate. OSHG System Supplier shall define particle retention and flow rate.

2.11 WATER SUPPLY PRESSURE CONTROL VALVE

A. Provide pressure control valve on main potable water supply pipe as shown on Drawings. Size pressure control valve to meet system flow and pressure requirements.

B. Manufacturer: Watts.

C. Provide pressure gauge with isolation valve downstream of pressure control valve.
2.12 VALVES AND PIPING

A. Provide required valves, piping, and tubing for manufacturer-assembled system as shown on Drawings.

B. Ball Valves for Water, Brine, Sodium Hypochlorite:

   1. PVC Ball Valves: Rated 150 psi at 73 degrees F, with ASTM D1784, Type I, Grade 1 polyvinyl chloride body, ball and stem, end entry, double union design, solvent-weld socket ends, elastomer seat, Viton or Teflon O-ring stem seals, to block flow in both directions. Provide pressure relief hole drilled on low pressure side of ball for sodium hypochlorite service.
      a. Manufacturers and Products:
         1) Nibco; Chemtrol Tru-Bloc.
         2) ASAHI/America; Type 21.
         3) Spears; True Union.

C. Equipment Connections: Make with flanges, unless 2 inches or smaller, which may be threaded.

2.13 INSTRUMENTS

A. Hydrogen Gas Monitor (P20AE0111, P20AIT0111):

   1. Provide self-contained gas analyzer(s) and transmitter(s) suitable for continuous monitoring hydrogen gas concentration from 0 percent to 100 percent of the Lower Explosion Limit in ambient room air.
   2. Provide a remote calibration adapter and calibration kit.
   3. Output: 4 mA to 20 mA dc analog signal to control panel for continuous monitoring. Unit shall be two-wire type or, if requiring an external power supply, suitable for power supply provided at system control panel. Provide monitoring of room hydrogen concentration, and alarm and system shutdown if gas concentration exceeds 25 percent of the LEL for hydrogen gas.
   5. Detection Accuracy: 1 ppm over a range of 0 ppm to 100 ppm.
   6. Enclosure: NEMA 4X.
   7. Options:
      a. Calibration kit, P1879.
      b. Calibration cap, P3013-RC.
      c. Calibration tubing, P1883-T.
      1) Length: 30 feet, cut to length in field.
      d. Hand held IR programmer/calibrator.
   8. Manufacturer and Product: Conspec Controls; CN6.
B. Ultrasonic Level Transmitter (P20LE0117, P20LIT0117):

1. Monitor level in sodium hypochlorite tank.

2. General:
   a. Function: Continuous, noncontacting level measurement.
   b. Type: Ultrasonic.
   c. Parts: Element, transmitter, interconnecting cable, and accessories as noted.

3. Service:
   a. Application: Sodium Hypochlorite.
   b. Vapor Space Pressure: Atmospheric, unless otherwise noted.
   c. Operating Temperature Range:
      1) Element: Minus 40 degrees F to plus 140 degrees F.
      2) Transmitter: Minus 4 degrees F to 113 degrees F.

4. Performance:
   a. Range: As required depending on tank dimension, up to 39 feet.
   c. Accuracy: Plus or minus 0.25 percent of maximum range.
   d. Resolution: 0.06 inch.
   e. Blanking Distance: 12 inches.

5. Element:
   a. IP68, waterproof.
   b. Housing: UPVC, unless otherwise noted.
   c. Other materials subject to Engineer approval.
   d. Process Connection:
      1) 1-inch NPT.
      2) Top mounted.
   e. Beam Angle: 12 degrees or less.
   f. Integral temperature compensation.
   g. Interconnecting Cable: Weatherproof, UV protected, length as required, and type as recommended by manufacturer.

6. Transmitter:
   a. Stanchion mount.
   b. Display, back lit.
   c. Integral keypad or nonintrusive external programming.
   d. Enclosure: NEMA 4X.
   e. Power Supply: 115 volts, 50/60-Hz, unless otherwise noted.
   f. Isolated Analog Output:
      1) One Minimum: 4 mA to 20 mA dc for load impedance of 0 ohm to 750 ohms.
   g. Discrete Outputs:
      1) Minimum, two relay (SPDT) rated for 2 amps continuous at 230V ac.
      2) Assignable.
7. Accessories:
   a. Submergence shield.
   b. Flange Mounting: As required to match supplied tank construction.

8. Manufacturer and Product: Rosemount; 3107 element with Rosemount 3491 transmitter.

C. Level Transmitter, Direct Sensing, Flange Mounted (P20LIT0113):

1. General:
   a. Function: Measure level in a process vessel.
   b. Type:
      1) Capacitive differential pressure cell.
      2) Diaphragm for process fluid isolation.
      3) Flange mounting.
      4) Smart electronics.
      5) Two-wire device.

2. Service:
   b. Process Temperature Range: Minus 20 degrees F to 400 degrees F.
   c. Ambient Temperature Range: Minus 40 degrees F to 250 degrees F.
   d. Humidity: 0 percent to 100 percent relative.

3. Performance:
   a. Range: To be specified by system supplier.
   b. Accuracy: Plus or minus 0.75 percent of span.

4. Features:
   a. Zero Suppression or Elevation: To be specified by system supplier.
   b. Damping: User-selectable; 0 second to 36 seconds time constant of analog output response to step change input.
   c. Transmitter: Two-wire, powered from external power supply.
   d. Zero and Span Adjustments: Local, external, noninteractive, unless otherwise noted.
   e. Process Wetted Parts: Flanged Process Connection (Transmitter High Pressure Side):
      1) Flange Size/Type: 3 inch, Class 150.
      2) Process Diaphragm: Type 316 stainless steel.
      3) Mounting Flange: Type 316 stainless steel.
f. Reference Process Connection (Transmitter Low Pressure Side) Configuration (Differential):
   1) Drain/Vent: Type 316 stainless steel.
   2) Flange Adapter: Stainless steel.
   3) Diaphragm Material: Type 316 stainless steel, unless otherwise noted.
   4) Sensor Fill Fluid (Low Pressure Side): Silicone.

g. O-Ring: Glass-filled TFE.

h. Flange and Adapter Bolts: Type 316 stainless steel.

i. LCD Meter: Included.

5. Signal Output Interface:
   a. 4 mA to 20 mA dc for load impedance 0 ohm to 580 ohms minimum at 24V dc supply voltage without load adjustment.
   b. Superimposed digital signal based on HART protocol.

6. Enclosure: NEMA 4X.


D. Solids Level Transmitter (P20LIT0013A):

1. General:
   b. Type: Cable.

2. Service:
   a. Application: Brine tank.
   b. Operating Temperature Range:
      1) Ambient: Minus 40 degrees F to plus 185 degrees F.
      2) Process: Up to 500 degrees F.

3. Performance:
   a. Accuracy: Plus or minus 0.25 percent distance measurement.
   b. Range: Up to 150 feet, to be specified by system supplier.

4. Housing:
   a. NEMA 4X.
   b. Molded polycarbonate.
   c. Mounting: 3 inch to 8 inch NPT, to be specified by system supplier.

5. Electrical:
   b. Output Signal: 4 mA dc to 20 mA dc.

E. Airflow Switch for Hydrogen Dilution Vent Pipe (P20FE0117, P20FSL0117):

1. Provide six vane operated flow switches, differential pressure switches, or orifice with differential pressure switches. Wetted parts shall be stainless steel or nonmetallic. Provide fail-safe operation, generating a system alarm and shutting off system if airflow falls below required minimum.
2. Manufacturers:
   b. Dwyer.

2.14 CONTROL SYSTEM

A. General:

1. Provide a complete PLC-based control system for the sodium hypochlorite generation system, except sodium hypochlorite feed pumps.
2. Generation System Supplier shall provide control software, debugged, and as required for system operation.
3. All instrumentation, control and electrical components shall comply with the requirements of Section 40 99 90, Package Control Systems.

B. Control Panel:

1. Shall provide for complete system control in automatic and manual modes.
2. Features:
   a. Main power disconnect.
   b. Local audible and visible alarm with alarm silence switch.
   c. Power ON indicator light.
   d. Display operating parameters, modes, status, and alarm conditions on a color graphic touch screen-type OIT mounted on front door of panel.
   e. Motor starters for blower.
   f. Variable speed drive for brine pump.
   g. UPS, installed within control panel enclosure, sized to power PLC and OIT for 30 minutes for ride through until plant generator is online.
3. Enclosure: In accordance with Section 40 99 90, Package Control Systems.
4. Panel shall conform to UL 508A and shall be labeled accordingly.
5. Control panel shall house PLC, motor controllers, and terminal blocks as required for all functions, including generator operation, hydrogen blower control, tank level control, brine metering pump proportional control, and system monitoring, alarms and safety shut down.

6. Unit PLC shall communicate with Plant PLC via Ethernet/IP network.

7. Programming provided by System Supplier shall be in coordination with programming provided by Engineer for a complete and functional system.

8. Arrange terminal blocks and internal wiring to maintain separation between signal, control, and power circuits.

9. Generation system control logic shall be provided by PLC, where operating parameters shall be measured, corrected, scaled, reported, and controlled. Safety functions shall be fail-safe and hard-wired.

10. Control Panel Power Supply: Shall be suitable for 208V ac, single-phase, control power and equipped for internally-derived power supply from blower and pump power supply circuit, with control power transformer, if necessary, and fuse-type protection on transformer primary and secondary.

11. Protection and Alarms:
   a. Provide control circuits to shut down rectifier system in the event of a fault.
   b. On front panel of enclosure, provide indication of type of fault that caused shutdown.
   c. Provide sensing for the following faults:
      1) Input power phase failure or voltage imbalance.
      2) Transformer winding high temperature.
      3) SCR heat sink high temperature.
      4) Cooling fan failure.
      5) dc current and voltage limits.
      6) Door interlock switch.
      7) Blower failure.
      8) Cell low level.
      9) Cell high temperature.
     10) Sodium hypochlorite tank high level.
     11) Brine pump failure.
     12) Sodium hypochlorite tank vent low air flow.

12. PLC and OIT shall meet the requirements of Section 40 99 90, Package Control Systems.

C. Unit control system shall control and monitor functions and operational parameters including, but not limited to, the following:

1. Rectifier control.
2. dc amperage.
5. Hypochlorite tank level.
6. Brine tank level.
7. Blower control.
8. Generator operating mode, including FAIL/ON/REMOTE/RUN/LOW-LOW controls and status indications.
10. Security protection.

D. Generation System Operation:

1. Automatically start and stop system based on high and low levels in sodium hypochlorite tank.
2. Water softener resin shall automatically be regenerated with salt solution from brine tank based on totalized water flow.
3. Provide alarm indication and logging for the following conditions:
   a. Cell low liquid level.
   b. Cell high temperature.
   c. Low brine or water flow.
   d. Rectifier improper voltage or current.
   e. Rectifier fault.
   f. Blower low air flow.
   g. Relief valve or rupture disc operation.
   h. Hydrogen level in the room.
      1) Provide fail-safe monitoring and alarm indication.
      2) Provide visual and audible alarm.
   i. LOW LOW level for storage tank.
   j. HIGH HIGH level for storage tank.
4. Display the following parameters locally at OIT:
   a. Brine pump status.
   b. Rectifier status.
   c. Dilution blower status.
   d. Hypochlorite tank level.
   e. Tank blower status.
5. Rectifier Protection and Alarms:
   a. Provide control circuits to shut down rectifier system in the event of a fault.
   b. Display type of fault that caused shutdown.
   c. Provide detection of the following faults:
      1) Input power phase failure or voltage imbalance.
      2) Transformer winding high temperature.
      3) SCR heat sink high temperature.
      4) Cooling fan failure.
5) dc current and voltage limits.
6) Door interlock switch.

6. Remote Monitoring Interfaces: All unit control, monitoring, and alarm functions available on OIT shall be available to be duplicated on the plant HMI by Engineer, allowing for remote monitoring and control of the system via the plantwide Ethernet/IP network.

2.15 RACEWAYS AND CONDUCTORS

A. Raceways, General:

1. Route wiring external to devices and other enclosures in conduit, except for DC power cables to generation cells shall be routed separately from AC circuits.
2. Conduit and fittings shall be listed products.
3. Enclosure penetrations shall maintain rating of enclosures.
4. Make final connection to motors, devices with process connections, or devices that may require removal or adjustment with flexible conduit.
5. Use PVC conduit where corrosion resistance is required and where protection from physical damage and support are provided.

B. Wiring, General:

1. Terminate wiring that interconnects devices, enclosures, and other system components on numbered terminal blocks.
2. Wire and cable shall be listed products.
3. Power and discrete control circuits shall include a code-sized equipment grounding conductor routed with the circuit conductors.
4. Instrumentation signal circuits shall use jacketed shielded cable with required conductor make-up.
5. Ground cable shields at one end only.
6. Identify wires and cables using permanent-labeled wire markers and a consistent naming system.

C. Conduit: Provide code-sized rigid galvanized steel or Schedule 40 PVC in accord with Section 26 05 33, Raceway and Boxes, and the Area Classification and Material Selection table on Drawings.

D. Cable and Conductors: Discrete conductors shall be stranded copper wire with Type THW or THWN insulation for circuits operating at greater than 50 volts in accordance with Section 26 05 05, Conductors. Multi-conductor cables shall be manufacturer’s standard product and assembly.
2.16 FACTORY FINISH

A. Shop prime and finish coat exposed metal surfaces, except stainless steel, brass, and bronze, of equipment and accessories.

B. Equipment, accessories, and skid fabricated of carbon steel shall be epoxy coated. Epoxy coating shall be as specified in Section 09 90 00, Painting and Coating.

2.17 SALT

A. Provide initial charge of salt to fill the brine tank to capacity.

B. Salt shall be coarse solar salt with NSF 60 certification for use in potable water. It shall have a size greater than 12 mesh, and shall contain no organic binders, flow control agents, or resin cleaning material, and shall meet the following specifications:

<table>
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<tr>
<th>Component</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>NaCl:</td>
<td></td>
</tr>
<tr>
<td>Dry Basis</td>
<td>96.3 percent minimum</td>
</tr>
<tr>
<td>Wet Basis</td>
<td>93.3 percent minimum</td>
</tr>
<tr>
<td>Fluoride</td>
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<tr>
<td>Manganese</td>
<td>0.0002 percent</td>
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<tr>
<td>Calcium Sulfate</td>
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<tr>
<td>Magnesium Chloride</td>
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<tr>
<td>Calcium Chloride</td>
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</tr>
<tr>
<td>Magnesium Sulfate</td>
<td>0.02 percent maximum</td>
</tr>
<tr>
<td>Insolubles</td>
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<tr>
<td>Moisture (as H2O)</td>
<td>3.0 percent maximum</td>
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<tr>
<td>Lead</td>
<td>0.0007 percent maximum</td>
</tr>
<tr>
<td>Copper</td>
<td>0.0003 percent maximum</td>
</tr>
<tr>
<td>Iron (as Fe)</td>
<td>0.002 percent maximum</td>
</tr>
</tbody>
</table>

2.18 ACCESSORIES

A. Furnish initial supply of greases and lubricants required to start operations.

B. Lifting Lugs: Provide suitably attached for equipment assemblies and components weighing over 100 pounds.

C. Equipment Identification Plates: Provide 16-gauge Type 304 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high
die-stamped block type black enamel filled equipment identification number indicated in this Specification and as shown on Drawings.

D. Device Nameplates: Provide devices, including front- or door-mounted operator interface devices with engraved plastic nameplates. Attach nameplates by adhesive or stainless steel panhead screws.

E. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Coat in accordance with Section 09 90 00, Painting and Coating.

2.19 SOURCE QUALITY CONTROL

A. General:
   1. Perform manufacturer’s standard factory inspections and tests prior to packaging and shipment.
   2. Testing procedures shall ensure proper operation of functions and demonstrate specified performance.
   3. Perform testing according to manufacturer’s standard procedure and forms.

B. Perform testing in accordance with Section 44 44 13.01, Chemical Metering Pumps.

C. Functional Tests:
   1. Test startup, operating, control, interlock, monitoring, safety and alarm, and shutdown functions. Testing shall include as a minimum:
      a. Startup sequence.
      b. Hypochlorite concentration test (titration).
      c. Generation capacity (lb/day) test.
      d. Shut down sequence.
      e. Simulation of critical alarms.

D. Performance Tests: Demonstrate operation in accordance with system design parameters, including specified design capacity. Minimum capacity shall be demonstrated to be equal to specified capacity and sodium hypochlorite concentration, while not exceeding maximum raw material and utility input quantities.

E. Continuous Operation Test: Test generator assembly for a minimum of 8 continuous hours and confirm proper operating parameters.

F. Factory Test Reports: Provide certified test reports; include data sheets.
PART 3  EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s printed instructions.

B. Anchor Bolts: Accurately place using equipment templates and as specified in Section 05 50 00, Metal Fabrications.

C. Grout or shim tie-down lugs for tanks to prevent excessive loads being transferred to tank shell.

D. Complete system mechanical connections, including water supply and drain for each piece of equipment.

E. Apply initial supply of salt and lubricants.

F. Complete electrical connections in conformance with requirements of Division 26, Electrical.

3.02 FIELD FINISHING

A. Field finish equipment as specified in Section 09 90 00, Painting and Coating.

3.03 FIELD TESTING

A. Hydrostatic Test:

1. Perform hydrostatic test on tanks after installation, but before piping connections are made.
2. Block outlets and fill each tank with water to check for leaks.
3. No leakage shall be permitted.

B. Functional Test:

1. Prior to plant startup, inspect equipment for proper installation, quiet operation, and proper connection.
2. Confirm system is operating.
3. Verify structures, equipment, pumps, and motors are compatible for an efficient system.
4. Make equipment adjustments required to place system in proper operating condition.
5. Demonstrate system functions, including control, interlock, safety and alarm, monitoring, and remote PLC and HMI interface in presence of Engineer.
C. Performance Test:

1. Conduct in presence of Engineer.
2. Perform under actual or approved simulated operating conditions for a continuous 8-hour period without malfunction.
3. Verify calibration of metering pumps using installed calibration columns.
4. Verify calibration of sodium hypochlorite and brine tank level transmitter.
5. Verify sodium hypochlorite concentration with samples taken at generator outlet once each half hour.
   a. Analyze Samples for available chlorine per AWWA B300.
   b. Average of the concentrations of the Samples shall be in the range of 0.75 percent to 0.85 percent.
6. Verify Chlorine Generation Capacity:
   a. Calculate on the basis of the average available chlorine concentration and volume of the produced sodium hypochlorite.
   b. Capacity shall be reported in pounds per day and shall equal or exceed capacity of system specified.
7. Verify Salt Consumption:
   a. Take brine sample once each half hour and measure temperature and specific gravity to determine salt concentration.
   b. Multiply average salt concentration by brine feed rate, based on brine pump calibration, and elapsed time of test period. Divide total salt consumption by total chlorine generated to determine pounds of salt used per pound of available chlorine produced.
   c. Salt consumption shall not exceed 3 pounds per pound of chlorine.
8. Verify Power Consumption:
   a. Furnish and connect power meter for test.
   b. Measure load in kilowatts at input to transformer/rectifier, including harmonic control or filter apparatus, during test period.
   c. Take power reading once per hour during test period.
   d. Total energy consumed shall be determined by multiplying the average of the hourly power reading times test duration in hours. Total chlorine produced in pounds shall be calculated from the above generation capacity. Total chlorine produced shall be divided by total energy consumed.
   e. Result shall not exceed 2.0 kWh per pound of chlorine.
9. Verify Water Consumption:
   a. Furnish and connect totalizing flow meter for test.
   b. Monitor softened water flow to generation unit for duration of test period.
c. Water consumption shall be calculated from the total water volume divided by the test duration and total chlorine produced in pounds.

d. Result shall not exceed 15 gpm of softened water per pound of chlorine equivalent output.

10. If sodium hypochlorite system fails to meet specified performance requirements, modify or replace equipment. Adjust and retest system until test results verify satisfactory operation.

3.04 MANUFACTURER’S SERVICES

A. Manufacturer’s Representative: Present at Site or classroom designated by a technician that is factory-trained by the OSHG Supplier and has demonstrated the ability and experience in the installation and operation of the equipment. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:

1. 1 person-day for installation assistance and inspection.
2. 2 person-days for functional and performance testing and completion of Manufacturer’s Certificate of Proper Installation.
3. 1 person-day for prestartup classroom or Site training.
4. 2 person-days for facility startup including LEL transmitter calibration training.
5. 1 person-day for post-startup training of Owner’s personnel. Training shall not commence until an accepted detailed lesson plan for each training activity has been reviewed by Owner.

B. Conduct services in accordance with Section 01 43 33, Manufacturers’ Field Services.

END OF SECTION
SECTION 46 61 33.13
INSTALLATION OF OWNER-FURNISHED
MEMBRANE FILTRATION SYSTEM

EQUIPMENT FURNISHED BY OWNER


PART 1 GENERAL

1.01 RELATED SECTIONS

A. See Section 01 64 00, Owner-Furnished Products, and Section 01 91 14, Equipment Testing and Facility Startup.

1.02 WORK OF THIS SECTION

A. Work necessary to receive, handle, store, maintain, and install the Owner-furnished membrane system equipment, and to assist with and coordinate testing and startup.

B. WesTech Engineering, Inc. Scope of Supply:

1. The WesTech membrane system is an Owner-furnished equipment package system, which includes:
   b. WesTech System Model UFT82A package membrane filtration units.
   c. Instrumentation and controls.
   d. Feed tank and feed pumps.
   e. Backwash pumps.
   f. Prefilter strainers.
   g. Process valves.
   h. Clean-in-place (CIP) and neutralization tanks and systems.
   i. Air compressors and receiver tanks.
   j. Chemical transfer pumps.
   k. Spare parts and custom tools.
   l. Some interconnecting pipe and appurtenances.

2. In addition, WesTech will provide O&M Manuals, installation, training, and startup assistance to the Owner and Contractor.
1.03 CONTRACTOR’S RESPONSIBILITY FOR COMPLETE SYSTEM

A. The Contractor is responsible for all labor and material required for the installation of all equipment. The membrane system procurement contract includes manufacturer’s services, including installation technical assistance.

B. The Scope of Supply and Contractor’s work is defined by the following:

1. CH2M HILL Drawings: CH2M HILL’s civil, mechanical, electrical, and I&C drawings depict the installed WesTech-supplied equipment and indicate items that are part of the membrane equipment package with a double solid diamond symbol. The CH2M HILL P&ID drawings primarily indicate equipment and systems outside the WesTech scope of supply, and therefore, are intended to complement the WesTech P&ID drawings.

2. WesTech Drawings: The membrane system supplier’s submittals were provided to the Owner under the procurement contract. The WesTech P&ID drawings utilize notes and phantom boundary symbols to indicate equipment and instrumentation in the WesTech Scope of Supply. Work items outside the WesTech scope of supply are oftentimes, but not always, designated as “by others”, which is work to be provided by Contractor. The P&IDs are schematic in presentation. They show the major equipment and instrumentation, but do not accurately depict the interconnecting piping, which is to be furnished and installed by the Contractor. The Contractor must refer to CH2M HILL’s mechanical drawings for this information.

3. WesTech Mechanical and Electrical Drawings: Drawings are attached to the Contract Documents. In general, these Drawings depict work by WesTech; however, refer to Drawing Notes for additional description of work breakdown depicted on WesTech’s Submittal Drawings.

4. WesTech Submittal Documents: These Submittal Documents contain both the WesTech Drawings and equipment cutsheets and technical information, including equipment and valve lists, system functional description, installation manual, and Startup Checklist, etc.

1.04 INFORMATION FURNISHED BY OWNER

A. WesTech Engineering, Inc.:

1. Contact Person: Nate Rogers, Project Manager.
2. Telephone: (801) 290-5642.
3. E-mail: nrogers@westech-inc.com.
B. The following information relating to the membrane system equipment will be provided to Contractor during Project construction to assist in installation and startup of equipment and systems:

1. Installation Instructions.

C. WesTech Drawings indicate work and equipment to be provided or performed by others. The reference to others on WesTech-prepared Drawings shall be understood to mean Contractor.

D. In cases where Work shown on the WesTech Drawings is also shown or indicated to be done differently on Engineer’s Drawings and Specifications, it shall be done in accordance with Engineer’s Drawings and Specifications.

1.05 SUBMITTALS

A. In accordance with Section 01 33 00, Submittal Procedures, and Section 01 64 00, Owner-Furnished Products. Coordinate with submittals for Section 01 91 14, Equipment Testing and Facility Startup.

B. Furnish, as a part of the Work under this Section and in coordination with submittal requirements in other Sections, detailed Shop Drawings to indicate the layout, location, and identification of materials provided by Contractor and how work interfaces with the membrane system.

1. Include piping, fittings, valves, specialties, hangers, supports, equipment, electrical, instrumentation, and control devices, and required specialties.
2. Accurately show openings in floors, walls, and other parts of the structures.
3. Provide electrical and instrumentation diagrams to indicate connecting and interconnecting electrical and control work.

C. Submit functional test logs and performance test reports as required for specific equipment tested.

1.06 SEQUENCING AND SCHEDULING

A. The Owner’s pre-purchase price for the Membrane Filtration System is based upon a specific shipment packaging from WesTech to the Project Site. An equipment delivery schedule with different provisions may require negotiation with WesTech and additional costs to be borne by the Contractor.
B. The Contractor shall be responsible for overall scheduling of equipment delivery to the Project Site. Contractor shall verify availability of equipment by contacting WesTech before making final arrangements for, or committing resources to, receiving, handling, protection, or installation of such products.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide all products required to complete the work under this Section.

B. Products to be provided by Contractor include, but are not limited to, concrete pads, inserts, anchor systems, piping and fittings, connectors, and valves, piping support systems, grating, handrailings, wiring, conduit, terminal junction boxes, conduit splice boxes, pneumatic tubing, piping accessories, specialties, finish painting, and expendable materials, spare parts and special tools, as defined herein, all as necessary to provide a complete and properly functioning system.

2.02 MISCELLANEOUS PRODUCTS

A. General: Unless indicated on Drawings, the equipment and instruments in the WesTech Scope of Supply will be shipped loose for installation by Contractor. Furnish incidental products, such as gaskets, transition spools, connecting hardware, supports, anchor systems, including bolts, hardware and adhesive, lubricants, conduit, terminal junction boxes, wiring, tubing, etc., as required for proper operation of equipment installed under this Section. Products shall conform to applicable Sections of these Specifications for the intended service and shall comply with manufacturer’s written Installation Instructions.

B. Equipment Foundation Pads: Provide foundation pads for equipment as shown on Drawings.

C. Anchor Bolts: Contractor to furnish anchor bolts, fasteners, adhesives, and all other required hardware for proper installation. Anchor bolts for WesTech-supplied equipment will be sized by WesTech and furnished by the Contractor.

1. Locate anchor bolts in accordance with WesTech-provided information and Installation Instructions. Coordinate requirements with WesTech and obtain necessary templates, spacers, etc.

2. Anchor bolts, fasteners, washers, etc., shall be Type 316 stainless steel.

3. Equipment anchorage and bracing shall be as specified in Section 01 88 15, Anchorage and Bracing.
D. For pipe supports, see Section 40 05 15, Piping Support Systems. Provide pipe supports for all piping, including WesTech-supplied piping. Do not support piping off of tank nozzles.

E. WesTech to provide 6-months of membrane cleaning and neutralization chemicals for startup and testing. It is anticipated that Owner will provide all other chemicals required for testing and startup.

PART 3 EXECUTION

3.01 GENERAL

A. Installation work shall conform to WesTech’s and equipment manufacturer’s recommended procedures, instructions, and Shop Drawings, and as approved by the Engineer.

B. Transport to its place of installation, inspect, store, handle, maintain, and protect equipment and products.

C. Maintain complete inventory on all membrane products after their transfer to Contractor.

D. Install piping, valves, and miscellaneous fittings in accordance with Drawings, manufacturer's instructions, and with Division 40, Process Interconnections.

E. Install and test instrumentation in accordance with Section 40 90 00, Instrumentation and Control for Process Systems, and Division 26, Electrical. Commissioning of the installed instrumentation shall be in accordance with Section 40 90 00, Instrumentation and Control for Process Systems. Contractor to furnish all piping, tubing, fittings, and miscellaneous items required for the panel installation.

F. Furnish, install, and connect electrical equipment as required and shown on Drawings and in accordance with Division 26, Electrical.
3.02 RECEIPT, HANDLING, STORAGE, PROTECTION, AND INSPECTION

A. Inspection Prior to Off-loading:

1. WesTech’s procurement contract with the District includes onsite services, including technical assistance during equipment off-loading and inspection. Upon delivery of materials to the jobsite, the Contractor, WesTech Representative, and Engineer shall jointly inspect the equipment for damages and shortages of equipment.
   a. Provide listing of the materials and/or equipment received, and provide written statement to the Engineer and WesTech that the materials and/or equipment were received in good condition.
   b. Report damage to or loss of materials and or equipment within 24 hours to the Engineer and to WesTech.
   c. Do not off-load products to be returned to WesTech for repair or replacement, unless necessary to expedite return shipping
   d. The Contractor is responsible for unpacking, repacking, and handling of the equipment as required.

B. Off-loading of Membrane Modules:

1. Off-load the Membrane Filtration System, after any damage or loss is reported, as specified in WesTech instructions, unless otherwise dictated by the Engineer.
2. Off-loading of Membrane Modules:
   a. Refer to the Installation Document referenced earlier for specific instruction.
   b. In general, note that the membrane modules are shipped from the factory in boxes containing bags with individual modules and a preservative solution. Upon receiving the modules, the boxes must be opened and inspected for any evidence of leaking or damage. The boxes must then be resealed and stored under conditions within WesTech-provided guidelines until installation.
   c. Storage requirements include protection from extreme heat or freezing and inside away from potential damage at the Project Site. Damage incurred during equipment off-loading shall be reported to the Engineer and WesTech as soon as possible, but in all cases within 24 hours.

C. Storage and Protection:

1. Following receipt of the Membrane Filtration System, and until final acceptance of the completed work, protect and maintain products to prevent damage or loss in accordance with WesTech instructions and as specified in Section 01 61 00, Common Product Requirements.
Contractor shall replace all materials and/or equipment that are lost or damaged while in the custody of the Contractor. Replacement materials and/or equipment shall be acceptable to the Owner, Engineer, and WesTech.

2. Maintain current, complete inventory and record of all Membrane Equipment System materials and equipment until final acceptance of the work by the Owner.


D. Insurance: Contractor shall include in the insurance for work under this Contract sufficient coverage to protect the Membrane Filtration System against all losses during off-loading, storage, protection, handling, and installation until final acceptance of the work by the Owner. The Owner and the Engineer shall be named as additional insured(s) for this work.

E. Maintenance: Notify the Owner and Engineer immediately in the event that WesTech spare parts and maintenance materials are not available when field testing is scheduled to begin.

F. Although the membranes are designed for maximum durability in filtration applications, the exposed membranes can be susceptible to irreversible damage during installation and commissioning due to mishandling. The Contractor is responsible for taking all reasonable precautions to prevent damage during installation and to prevent debris and foreign objects entering interfacing piping or tanks after the modules are installed. The Contractor shall obtain the installation manuals and other similar guidance, from WesTech prior to requesting delivery of equipment, and shall provide written statement to the Engineer indication that the Contractor has reviewed this document and will conform with requirements as indicated. Any concerns regarding membrane handling or potential damage should be addressed with WesTech and the Engineer before any activities are undertaken at the Project Site that may cause an increased potential for membrane damage to occur.

G. Refer to Section 01 61 00, Common Product Requirements, for additional requirements relating to handling, storage, and protection of equipment.

H. Dilute and dispose of the membrane preservative solution in accordance with local, state, and federal regulations. Each membrane module will be shipped to the Site filled with 1 gallon to 2 gallons of 20 mg/L sodium hypochlorite preservative solution (76 gallons to 152 gallons total). Contractor shall collect the concentrated preservative solution in a suitable tank for onsite neutralization or dilution and disposal offsite. The residual solution shall be rinsed from the modules (using water from the intake) and the rinse water disposed of along with the more concentrated chlorine solution.
Approximately 30 gallons to 40 gallons of rinse water is required per module (2,280 gallons to 3,040 gallons total). Contractor shall provide all tanks, piping, fittings, etc., required for dilution and handling of the preservative.

3.03 INSTALLATION

A. Refer to WesTech’s proposal for specific manufacturer’s services provided under the assigned Contract. WesTech will provide the following manufacturer’s services. Contractor is to coordinate and schedules these services.

1. Unloading and Installation Assistance: 5 person-days in one trip.
2. Functional and Performance Testing, Completion of Certificate of Proper Installation: 5 person-days in one trip.
3. Pre-startup Training: 3 person-days for classroom and field training in one trip.
4. Post-startup Training: 4 person-days in two trips.
5. Facility Startup: 10 person-days in two trips.
6. Telephone Support: 24/7 access to qualified representative during 1-year Monitored Test Period.

B. Provide supervision, labor, tools, construction equipment, incidental materials, and necessary services required to install and test the membrane equipment.

C. All work shall conform to applicable standards, final stamped and reviewed Shop Drawings, Specifications, and Drawings included in these Contract Documents.

D. Field verify actual dimensional requirements prior to fabricating materials that interconnect or support the membrane equipment and materials.

E. Obtain services from manufacturers or manufacturer’s representatives to assist in the installation, startup, and field testing of equipment listed herein. Efficiently coordinate, schedule, and utilize the services of WesTech’s representatives. Refer to reference documents for description of WesTech’s required services for testing and startup.

F. Contractor to arrange for and pay all costs associated with installation, testing, and startup assistance required beyond the manufacturers services outlined above and/or elsewhere in the assigned WesTech contract.

G. As specified in Section 01 61 00, Common Product Requirements, Article Installation.
3.04 FIELD FINISHING

A. Field finish coatings and touchup shall conform to the requirements of Section 09 90 00, Painting and Coating. Verify compatibility of field finish and touchup with manufacturer’s or WesTech factory coatings prior to proceeding.

3.05 FIELD QUALITY CONTROL

A. General:

1. Perform field testing as specified in Section 01 91 14, Equipment Testing and Facility Startup.
2. Perform field testing of instrumentation as specified in Section 40 90 00, Instrumentation and Control for Process Systems, and Division 26, Electrical.
3. Prepare all test logs and reports for submission.
4. Test piping systems as specified in Section 40 80 01, Process Piping Leakage Testing.

B. Preinstallation Meeting: Arrange and attend a preinstallation phone conference scheduled at least 45 days prior to shipment with the WesTech field staff to review general procedures, installation instructions, and installation sequence.

1. The Contractor shall provide 15 days advance written notice of the proposed date for starting installation of the membrane skids.
2. Additional meetings prior to installation may be required to transmit the WesTech installation instructions to the Contractor.
3. Notify Engineer and Owner of meeting times and locations.

C. Preparation: Prepare membrane system equipment for startup with WesTech assistance. Furnish incidental materials required for this preparation.

1. Check and adjust settings of components prior to startup.
2. Verify that equipment has been serviced with proper lubricants and that applicable safety equipment has been installed.
3. Verify that proper mechanical, electrical, instrumentation, and control connections have been made.
4. Correct misalignment, vibration, excessive noise, or other evidence of improper setting.
5. Correct defects in installation as required by manufacturer's instructions and recommendations.
6. Manufacturer’s certification of proper installation for each equipment system must be received by Engineer prior to starting functional testing. WesTech is responsible for certifying installation of their equipment. Coordinate schedule and documentation with WesTech.

7. Ensure all systems outside the WesTech scope of supply, e.g., raw water and finished water pumping systems, plant service water, chemical systems, etc., are available to support the functional and performance testing. Provide operations manuals and schedule training on all systems in advance of testing.

D. Functional Tests – Membrane Equipment and Systems:

1. Assist WesTech with all inspection, certification, calibration, field testing, and startup of equipment and systems.
2. Assist WesTech in making adjustments to installed equipment.
3. Provide written certification of proper installation to Engineer and coordinate functional testing of the Membrane Filtration System.
4. The Contractor and WesTech shall operate all membrane filtration system valves, controls, and other devices to ensure they are functional and ready for performance testing.
5. The Owner will provide raw water and other utilities for use in the Functional Test per the Contract Documents.
6. The Contractor and WesTech shall complete all functional testing to the satisfaction of the Engineer and the Owner prior to commencing the Initial Performance Test.
7. Functional Test: Test or tests in the presence of Engineer and Owner to demonstrate that installed equipment meets manufacturer’s installation, calibration, and adjustment requirements and other requirements as specified. Functional tests shall demonstrate the functionality of the membrane system, including the following:
   a. Automatic START/STOP and flow control of feed pumps and membrane racks using system and plant controls.
   b. Manual flow control using membrane train HMI(s) and PLC(s).
   c. Automatic cleaning of prefilter strainers using differential pressure.
   d. Automatic backwashing of filters at various time intervals.
   e. Automatic shutoff and alarm for various failure modes for each membrane package unit and for entire Membrane Filtration System.
   f. START and STOP of air systems.
   g. Automatic membrane integrity test system.
   h. Determination of clean water permeability of each membrane train and temperature correction of the clean water permeability for each train.
i. Monitoring and recovery of operating data.

j. Monitoring and control from remote workstation.

k. All control functions, both at primary and remote workstation.

l. Operation of chemical transfer and cleaning systems, including spent cleaning solution waste neutralization.

m. Operation of all monitoring instruments.

n. Backup power operation.

E. Performance Test for Membrane Equipment and Systems: Test or tests performed after any required functional test in presence of Engineer and Owner to demonstrate and confirm individual equipment meets performance requirements.

1. Following completion of the Functional Test and calibration of all instruments, the Contractor shall assist WesTech in conducting the Initial Performance Test of the Membrane Filtration System.

2. WesTech and the Contractor shall provide the Performance Test Report within 10 working days of completion of the test period.

3. To perform the test, WesTech and the Contractor shall operate the overall plant, including the Membrane Filtration system and all process, electrical, instrumentation and control interfaces continuously over a 14-day test period, and collect and summarize data to demonstrate that the system meets the performance test requirements.

4. Successful completion of the Performance Test shall be defined as 14 continuous days of operation without a major failure in any component of the Plant and demonstration that the overall treatment plant meets all performance requirements established for the Project.

F. Monitored Test Period: Membrane Equipment and Systems.

1. Compliance with the performance requirements for recovery, production capacity, CIP interval, membrane filtered water quality, and energy use shall be determined during a Monitored Test Period.

2. The Owner, with assistance from WesTech, will perform a Monitored Test of the completed system after Substantial Completion. Contractor is not responsible for the Monitored Test; however, Contractor shall coordinate remaining Work activities at the Project Site with WesTech’s and Owner’s testing program.

END OF SECTION