State of Washington
DEPARTMENT OF FISH AND WILDLIFE
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Office Location: 600 Capitol Way North, Olympia, WA

December 4, 2018

TO: ALL PLAN HOLDERS

SUBJECT: Tumwater Falls Facility Modification
TN:H71:14-1
ADDENDUM 1

The following changes and /or revisions constitute Addendum Number 1 and are hereby made part of the Drawings and Specifications.

SPECIFICATIONS:

The Specifications are amended as follows:

DIVISION 6 – WOOD & PLASTICS

SECTION 06820 – FIBERGLASS REINFORCED PLASTIC GRATING

ADD: 06820 Fiberglass Reinforced Plastic Grating Section dated REV 3/18:Last printed 11/7/2016 5:17:00 PM

DIVISION 16 – ELECTRICAL

SECTION 16050 – BASIC MATERIALS AND METHODS

REPLACE: 16050 Basic Materials and Methods dated REV 10/05:Last printed 11/27/2018 3:22:00 PM

WITH: 16050 Basic Materials and Methods dated REV 10/05:Last printed 12/3/2018 10:33:00 AM

SECTION 16210 – ENCLOSED STANDBY GENERATOR

REPLACE: 16210 Enclosed Standby Generator dated REV 12/02:Last printed 11/27/2018 3:22:00 PM

WITH: 16210 Enclosed Standby Generator dated REV 12/02:Last printed 12/3/2018 10:33:00 AM

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SECTION 16230 – AUTOMATIC TRANSFER SWITCH

REPLACE: 16230 Automatic Transfer Switch dated REV 10/05:Last printed 11/27/2018 3:22:00 PM

WITH: 16230 Automatic Transfer Switch dated REV 10/05:Last printed 12/3/2018 10:33:00 AM

SECTION 16430 – VARIABLE FREQUENCY DRIVES

REPLACE: 16430 Variable Frequency Drives dated 09/20/2016

WITH: 16430 Variable Frequency Drives dated REV 06/2016:Last printed 12/3/2018 10:31:00 AM

SECTION 16480 – MOTOR STARTERS

REPLACE: 16480 Motor Starters dated REV 10/05:Last printed 11/27/2018 3:23:00 PM

WITH: 16480 Motor Starters dated REV 10/05:Last printed 12/3/2018 10:31:00 AM

SECTION 16500 – LUMINAIRES

REPLACE: 16500 Luminaires dated REV 10/05:Last printed 11/27/2018 3:23:00 PM

WITH: 16500 Luminaires dated REV 10/05:Last printed 12/3/2018 10:55:00 AM

END OF ADDENDUM NUMBER 1

Sincerely,

Glenn F. Gerth, P.E.
Chief Engineer
Capital and Asset Management Program

cc: Harrison Knetchtel, Project Manager
Contract File
Project Folder

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SECTION 06820
FIBERGLASS REINFORCED PLASTIC GRATING

PART 1 - GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE:

The provision and intent of the contract, including the General Conditions, Supplementary Conditions, and General Requirements apply to this work as if specified in this section.

1.02 DESCRIPTION OF WORK

The work shall consist of furnishing all materials, labor, and equipment for fabricating and installing fiberglass reinforced plastic (FRP) grating, with all appurtenances, accessories and incidentals necessary to produce a complete, operable and serviceable installation, all in accordance with Drawings, notes, and this Specification.

1.03 QUALITY ASSURANCE

A. All items to be provided under this Section shall be furnished only by manufacturers having a minimum of 10 years' experience in the design and manufacture of similar products and systems. Additionally, if requested, a record of at least five (5) previous, separate, similar successful installations in the last 5 years shall be provided.

B. Manufacturer shall offer a 3 year limited warranty on all FRP products against defects in materials and workmanship.

C. Manufacturer shall be certified to the ISO 9001-2000 standard.

D. Manufacturer shall provide proof of certification from at least 2 other quality assurance programs for its facilities or products (UL, DNV, ABS, USCG, AARR).

1.04 REFERENCE STANDARDS

A. ASTM D 635 Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.

B. ASTM E 84 Surface Burning Characteristics of Building Materials.

1.05 SUBMITTALS

A. Submit shop drawings of all fabricated gratings and accessories in accordance with the provisions of this Section.

B. Manufacturer's shop drawings shall clearly show material sizes, types, styles, part or catalog numbers, complete details for the fabrication and erection of components including, but not limited to, location, lengths, type and sizes of fasteners, clip angles, member sizes, and connection details.

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C. Submit manufacturer's published literature including structural design data, structural properties data, grating load/deflection tables, corrosion resistance tables, certificates of compliance, test reports as applicable, concrete anchor systems and their allowable load tables, and design calculations for systems not sized or designed in the contract documents.

D. The Contractor may be requested to submit sample pieces of each item specified herein for acceptance by the Engineer as to quality and color. Sample pieces shall be manufactured by the method to be used in the work.

1.06 PRODUCT HANDLING

A. Delivery of Materials: Manufactured materials shall be delivered in original, unbroken pallets, packages, containers, or bundles bearing the label of the manufacturer. Adhesives, resins and their catalysts and hardeners shall be crated or boxed separately and noted as such to facilitate their movement to a dry indoor storage facility.

B. Storage of Products: All materials shall be carefully handled to prevent them from abrasion, cracking, chipping, twisting, other deformations, and other types of damage. Adhesives, resins and their catalysts are to be stored in dry indoor storage facilities between 70 and 85 degrees Fahrenheit (21 to 29 degrees Celsius) until they are required.

PART 2 - PRODUCTS

2.01 GENERAL

A. All FRP items furnished under this Section shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet the design requirements and dimensions as specified in the Contract Documents.

B. Fiberglass reinforcement shall be continuous roving in sufficient quantities as needed by the application and/or physical properties required.

C. Resin shall be Vinyl Ester or Isophthalic Polyester, with chemical formulations as necessary to provide the corrosion resistance, strength and other physical properties as required.

D. All finished surfaces of FRP items and fabrications shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure due to wear or weathering.

E. All grating products shall have a tested flame spread rating of 25 or less per *ASTM E-84 Tunnel Test*. Gratings shall also have tested burn time of less than 30 seconds and an extent of burn rate of less than or equal to 10 millimeters per *ASTM D635*.

F. All mechanical grating clips shall be manufactured of *Type 316SS* (stainless steel).

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2.02 PULTRUDED FRP GRATING

A. Manufacture: Grating components shall be high strength and high stiffness pultruded elements having a maximum of 70% and a minimum of 60% glass content (by weight) of continuous roving and continuous strand mat fiberglass reinforcements. The finished surface of the product shall be provided with a surfacing veil to provide a resin rich surface which improves corrosion resistance and resistance to ultraviolet degradation. Bearing bars shall be interlocked and epoxied in place with a two piece cross rod system to provide both a mechanical ad chemical lock.

B. Non–Slip Surfacing: Grating shall be provided with a quartz grit bonded to the top surface of the finished grating product.

C. Fire Rating: Grating shall be fire retardant with a tested flame spread rating of 25 or less when tested in accordance with *ASTM E 84*. Data performed only on the resin shall not be acceptable.

D. Resin System: Manufacturer may be required to submit corrosion data from tests performed on actual grating products in standard chemical environments. Corrosion resistance data of the base resin from the manufacturer is not a true indicator of grating product corrosion resistance and shall not be accepted.

E. Color: Gray

F. Depth: As required to meet capacity and deflection criteria.

G. Open Area: 50% maximum in sorting facility; 60% maximum on distribution boxes.

H. Maximum Span: 8 Feet

.I. Load/Deflection: Grating design loads shall be less than manufacturers published maximum recommended loads. Maximum recommended loads shall be determined by acoustic emission testing. Grating shall be designed for a uniform load of 100 psf or concentrated load of 300 lb. Deflection is not to exceed 0.375" or L/120, whichever is less.

J. The manufacturer shall certify that the stiffness of all panels manufactured are never more than 2.5% below the published load-deflection values.

K. Substitutions: Other products of equal strength, stiffness, corrosion resistance and overall quality may be submitted with the proper supporting data to the engineer for approval.

2.03 GRATING FABRICATION

A. Measurements: Grating supplied shall meet the dimensional requirements and tolerances as shown or specified. The Contractor shall provide and/or verify measurements in field for work fabricated to fit field conditions as required by grating manufacturer to complete the work. When field dimensions are not required, contractor shall determine correct size and locations of required holes or cutouts from field dimensions before grating fabrication.

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B. Layout: Each grating section shall be readily removable, except where indicated on drawings. Manufacturer to provide openings and holes where located on the contract drawings. Grating openings which fit around protrusions (pipes, cables, machinery, etc.) shall be discontinuous at approximately the centerline of opening so each section of grating is readily removable.

C. Sealing: All shop fabricated grating cuts shall be coated with vinyl ester resin to provide maximum corrosion resistance. All field fabricated grating cuts shall be coated similarly by the contractor in accordance with the manufacturer's instructions.

D. Hardware: Type 316 stainless steel hold-down clips shall be provided and spaced at maximum of 4 feet apart with a minimum of four (4) per piece of grating, or as recommended by the manufacturer.

2.04 POTENTIAL PRODUCT SOURCES

A. Fibergrate Composite Structures Inc.
22450 South Parrot Creek Road
Oregon City, OR 97045
Tel (503) 657-8998 Fax (503) 722-7727

B. American Grating, LLC.
16651 East Johnson Drive
City of Industry, CA 91745, USA
Toll Free (800) 266-2258, Tel (626) 855-1777, Fax (626) 855-1127

C. AMD, Inc.
405 Lively Blvd.
Elk Grove Village, IL 60007
Tel (847) 593-1800 Fax (847) 593-1830

PART 3 - EXECUTION

3.01 Prior to all work of this section, carefully inspect the installed work of all other trades affecting this work and verify that all such work is complete to the point where this installation may properly commence.

3.02 INSTALLATION

Contractor shall install gratings in accordance with manufacturer's assembly drawings. Fasten grating panels securely in place with hold-down fasteners as specified herein. Field cut and drill fiberglass reinforced plastic products with carbide or diamond tipped bits and blades. Seal cut or drilled surfaces in accordance with manufacturer's instructions. Follow manufacturer's instructions when cutting or drilling fiberglass products or using resin products; provide adequate ventilation.

END OF SECTION 06820

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SECTION 16050
BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

This section includes all raceways, fittings, hangers, wire, cable and terminations, and wiring devices, plates, and other appurtenances required for a complete and operational installation.

PART 2 - PRODUCTS

2.01 CONDUITS AND RACEWAYS

A. All underground and in-slab raceways shall be *Schedule 40* or *Schedule 80* PVC conduit unless the code requirement or Engineer specify otherwise, or if it is subject to severe physical damage. Raceway emergence from the ground or through the cement slab shall be Galvanized Rigid Steel (GRS) up to the equipment it supplies, unless vibration dictates the use of liquid-tight flexible metal conduit. Outside aboveground raceways shall be rigid galvanized steel unless otherwise noted on the Drawings. Electrical metallic tubing may be used in interior work to the extent permitted by code in sizes not to exceed 4 inches.

B. Surface metal raceways and wireways shall be rigid metal with hinged or screwed cover, painted steel, fittings, knockouts, of *NEMA 1* and *3R*.

C. Flexible metal conduit, flexible non-metallic conduit, liquid-tight flexible conduit and cable will be allowed only when specifically approved by the Engineer.

D. CONDUIT BODIES (Condulets: LB, LR, LL, T, C) shall be malleable iron with cover and gasket designed for the fitting. "Die-cast" or "pot-metal" condulets are not permitted. Condulet shall be properly sized for the conductors it contains.

2.02 FITTINGS

A. Galvanized Rigid Steel (GRS) fittings, couplings, and connectors shall be galvanized malleable iron or non-corrosive alloy compatible with galvanized conduit, and have threaded connections. Erickson couplings, watertight split couplings (OZ type or equivalent) are permitted. Running-thread or setscrew type fittings are not permitted. Bushings shall be insulating or insulated throat type.

B. EMT fittings, couplings, and connectors used in damp or wet locations shall be rain-tight, steel or malleable iron type utilizing a split corrugated compression ring and tightening nut or stainless steel locking disk. Steel setscrew fittings are permitted in dry locations (not in wet locations or in concrete). Zinc, pot metal, die cast fittings, and indenter fittings are not acceptable. Bushings shall be insulating or insulated throat type.

C. PVC fittings, couplings, and connectors shall be full weight cementable type.

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D. Conduit fittings and supports are not shown on the Drawings. The Contractor shall provide all fittings and supports required to suit the conditions.

2.03 CONDUCTORS

A. All conductors shall be copper (no aluminum), unless otherwise approved by the Engineer. *Size No. 8 AWG* and larger conductors shall be insulated, soft-drawn, *Class B* stranded copper. Minimum conductor size shall be *No. 12 AWG* unless otherwise noted. Insulation shall be *Type THHN, THWN-2, USE-2, or THW-2, XHHW*, 600V, minimum rated 90°C, and be color coded in a consistent manner. Direct-burial underground power cables shall be No. 12 and larger, 600-volt, *NEC Type UF* or *USE.* Conductors shall not be direct buried unless approved by the Engineer. *Romex* (nonmetallic sheathed cable) of the grounding type may be used for residential wiring when used in compliance with *NEC and WAC* code requirements. Flexible Cords shall be *UL* listed for outdoor use and allowed only when approved by the Engineer.

B. Conductors shall have colored insulation, except wires larger than No. 6 may be black with colored tape identification at all terminations and splices. Additional colors may be used where such colors will help in identifying wires and different systems. Where conductors of different systems are installed in same raceway, box, or other type enclosure, comply with *NEC 300.3 (C) (1)*. Color-coding of phase conductors shall be accomplished with colored tape approved by Engineer for sizes larger than *No. 6 AWG*. Identify control wire at each end and in all junction boxes, manholes, panels, switchboards, and other enclosures with designated wire number corresponding to control schematics.

2.04 SPLICES AND JOINTS

A. Splices above grade shall be in junction or outlet boxes only, using factory manufactured, insulated wire connectors as stated below.

1. Wire No. 10 or Smaller: Pre-insulated twist-on-type spring connector (Wire Nuts). (*3M, Ideal,* or equal).

2. Wire No. 8 or Larger: Pre-insulated Mechanical Connectors. ILSCO PBTS (or equal). Other methods require Engineer approval.

3. Terminator Lugs of No. 10 Wire and Smaller: Insulated, spade-type, tool applied eye connectors.

B. Underground feeder and branch circuits shall be pulled continuous without splices unless otherwise shown or approved. No direct burial splices shall be made without prior approval. Necessary and approved splices shall be made in handholes by one of the following methods:

1. *Ilsco, NSI or equal Mechanical Watertight Underground Splice Kits. Ilsco USPA-SS, or SS SSK. NSI "Polaris Blue" or ISPB, ISPC Series..*

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2. Solderless connectors (Ilsco "SPA" or equal) overlaid with rubber splicing tape to 2 ½ times the original insulation thickness, and then covered with 2 half-lap layers of *Scotch No. 33* or equal electrical tape. The completed splice shall then be sealed with Heat-Shrink type insulating cover (Ideal TS-46 or equal) approved for direct bury. In multi-conductor cables, each conductor shall be spliced, with splices staggered, and then all splices double half-lap wrapped with both rubber and electrical tape and sealed.

3. Direct bury or Handhole connector for wire size 10 *AWG* and smaller: Insulated steel spring twist-on presser connector with plastic cap with prefilled sealant gel listed for the purpose. (Ideal Weatherproof Wire-nut or equal) Approved Mechanical splice kits may be used for multi-wire cables. Treat connections with oxide inhibitor and seal with Heat-Shrink sleeve.

2.05 SEALING

A. Fire Seal: Not used.

B. Thermal Seal: Not used.

C. Water Seal: Seal conduits when required by NEC 225.27 or NEC 300.5G.

2.06 BOXES AND ENCLOSURES

A. Boxes include outlet, pull, and junction boxes. Size as required by *NEC*. In dry locations, boxes shall be galvanized sheet metal. In outdoor and wet locations, boxes shall be weatherproof with weatherproof covers and threaded hubs.

B. Handholes for buried conduit shall be precast concrete with steel top covers, unless otherwise noted on the Drawings. The covers shall be fabricated from galvanized steel diamond plate and have provisions for grounding the cover and ring. The entire assembly shall be designed with *AASHTO HS-20* design loads. Handholes shall be *Old Castle or Fog-Tite* manufacturer or equal, and correctly sized for the conduit and wire installed. See detail on the Drawings. Vaults or Handholes for primary voltage cables must meet local utility standards.

C. Alarm, cable, and telephone handholes shall be *Fog-Tite #J-11A, Type 1 C, D, G*, or rated equal.

D. All handholes shall be marked on the cover with the intended use: *ELECTRICAL*, *TELEPHONE*, *ALARM*, or *CABLE*.

2.07 SWITCHES

Switches shall be 20-amp/125-volt toggle-type, *Hubbell, Leviton,* or other approved type unless called out as special.

2.08 RECEPTACLES

A. General purpose receptacles shall be straight blade, 3-wire, safety-grounded, duplex type, 20-amp/125-volt, *Hubbell, Leviton,* or other approved type, except where called out as special. GFI-type receptacles shall have an automatic trip device and a sensing and

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testing circuit. Individual GFCI receptacles shall be 15-amp with 20-amp feed-through rating, unless called out as special.

2.09 CIRCUIT AND MOTOR DISCONNECTS

All circuit or motor disconnects shall be of the circuit breaker type (no fuses). Enclosures shall be of the proper type for the intended location or as indicated on the Drawings.

2.10 SUPPORTING DEVICES

A. Suspended Conduits Less Than 1 ½ Inch: For exposed construction, provide strap-type hangers supported from beam clamps or threaded rods. For conduits suspended above ceilings, anchor to building structural steel. When span exceeds *NEC* limits, provide channel steel between framing members. Tie wiring of conduit to air ducts or other piping is not permitted. Plumber's perforated strap is not permitted.

B. Suspended Conduit 2 Inch or Larger: Provide threaded rod with "U"-type hangers for single conduit. Anchor threaded rod to inserts in concrete or beam clamp on steel structure. Provide trapeze hanger assemblies and threaded rod for 2 or more conduits. Adhere to all applicable seismic support requirements.

C. Surface Mounted Conduit: Provide 1-hole galvanized steel straps for conduits 1-inch or less. Provide clampbacks on exterior walls below grade or in wet areas. For conduit larger than 1 inch, use malleable iron pipe straps. For multiple conduits, provide channel anchored to wall with conduit attached to channel with split pipe (strut) clamps.

PART 3 - EXECUTION

3.01 INSTALLATION OF CONDUIT, RACEWAYS, AND FITTINGS

A. Install conduits and raceways concealed in construction of finished spaces unless noted otherwise on the Drawings or specifically approved in writing by the Engineer. Concealed conduits shall be run in a direct line with long sweep bends and offsets. Exposed conduits and raceways shall be run parallel to and at right angles to building lines, and mounted in the least obvious locations unless otherwise approved. All underground conduits running longer than 300 feet shall have long radius sweep bends. Bending radius shall be 12 times the nominal diameter of the conduit.

B. Conduits and raceways shall be continuous from outlet to outlet, and from outlets to cabinets, pull or junction boxes, and shall be secured to all boxes with locknuts, and bushings installed in such a manner that each system shall be electrically continuous throughout. Conduit ends shall have a manufactured end cap to prevent entrance of foreign materials during construction.

C. Joints shall be cut square, reamed smooth, and drawn tight. Bends or offsets shall be made with standard conduit ells; field bends made with a bender or hickey, or hub-type conduit fittings. Number of bends per run shall conform to *NEC* limitations. Bends shall conform to *NEC* radius requirements and shall not have kinks or flat spots.

D. Install galvanized rigid steel for all conduits upon emergence from ground (to related equipment enclosure), up through concrete slab, and where subject to physical damage and as noted on the Drawings. Connections shall be watertight in damp or wet locations.

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EMT may be installed for wiring in masonry block, in framed construction, furred ceilings, above suspended ceilings, and exposed unfinished dry location spaces not subject to physical damage. EMT shall not be installed underground, under concrete slabs, or in concrete slabs on grade.

3.02 FLEXIBLE CONDUIT

A. Provide flexible conduit connection to motors and equipment subject to vibration with at least a 60° loop to allow for isolation and flexibility. Use metallic type liquid-tight for all pumps, motors, and equipment that are regularly washed down and for equipment in wet or damp locations. Provide bonding jumper as required by *NEC.*

B. Type MC cable may be used from junction boxes to fixtures in concealed ceiling areas in lengths not to exceed 8 feet or as directed by the engineer. Any other use of armored cable must be approved by the engineer.

3.03 UNDERGROUND INSTALLATIONS

A. All trenching and backfilling shall be Contractor supplied. Trenching for underground services shall be as required by the serving utility. All other distribution line trenching shall be as required by code and as shown on the Drawings. General trenching, backfilling, and compaction shall be as described in *DIVISION 2 – SITEWORK.* Appropriate bedding and backfill material approved by the Engineer shall be used. The Contractor shall coordinate backfilling of incoming service lines with utility company personnel. Yellow or red warning tape over all underground runs 12 inches above the electrical installation. Surface of warning tape shall be labeled with the words "*CAUTION – BURIED ELECTRICAL CABLE*" printed on it.

B. Ground shall be excavated in open trenches to the width, depth, and direction necessary for the proper installation of the underground work. Burial depth of underground raceways shall not be less than *NEC* minimums and shall be deeper where so noted herein or required to avoid conflicts. Maintain all trenches and excavations free of standing water. Conduit shall be bedded firmly and continuously on sand or pea gravel, and provide a minimum of 6 inches of covering of sand or pea gravel on all sides of conduit prior to final backfilling.

C. Handholes shall be installed with top of handhole set flush with top of finished grade. All entrances to handholes shall be suitably sealed to prevent the entrance of foreign material. Handholes & Vaults shall be installed square with adjacent structures, fences, roads, etc.

D. Galvanized rigid steel and PVC are acceptable for underground use where permitted by code. Provide code-sized ground wire in all underground conduits, steel or PVC. Conduit emergence into handhole may be PVC unless the run is over 300 feet; then all 90° bends shall be rigid steel.

E. Arrange and slope conduits entering buildings to drain away from the point of entry, or if impractical, provide for the drainage of water entering the building through the conduit system.

F. Conduits passing through the exterior walls below grade and/or bridging areas of naturally unstable soil conditions or previously filled areas shall be placed in a manner to

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avoid crushing from ground settlement. Backfill under conduit shall be thoroughly compacted. Use approved deflection fitting on conduits such as *OZ type DX*.

G. Conduits in the foundation area shall be installed so as not to undermine the footings. Install all inserts and sleeves necessary for *DIVISION 16* installation prior to pouring of concrete slabs and walls. Check structural Drawings for any specific instructions. Backfill over conduits under footings and concrete slabs shall conform to the requirements of the Structural Engineer. Use lean concrete unless otherwise noted.

H. Minimum spacing between conduits in trenches shall be 1 inch.

I. Locate all underground utilities before any excavation is attempted, including but not limited to power utility, telephone, gas, water, cable, alarm, and secondary service laterals.

3.04 CONDUCTOR INSTALLATION

A. Do not pull any cable or wire in a raceway until conduit system is complete and internal raceway has been cleaned. Strain on cables shall not exceed manufacturer's recommendations during pulling. Pulling shall be done from the conductor and not by the insulation. Use pulling lubricant compatible with insulation and covering that will not cause deterioration of insulation or jacket covers of cables or conductors. Do not make splices except in outlet or junction boxes. Make all feeder cables continuous from origin to panel or equipment terminations without running splices in intermediate pull or boxes, unless specifically indicated on the Drawings or approved in writing by Engineer.

B. All wire shall be stranded copper. Use minimum wire sizes in no case less than shown on the Drawings. Do not exceed conduit fill established by *NEC*.

C. Provide each cable or conductor in panels, pull boxes, or troughs with a permanent pressure-sensitive label with suitable color, numbers, or letters for easy identification. Identify control wires at each end and in junction boxes with designated wire numbers corresponding to control schematic drawings.

D. Provide wires and cables entering equipment or panels with enough slack to eliminate stretched, angular connection. Neatly arrange wiring bundle and fan out to termination panels. Make minimum bending radius for conductors in accord with *NEC*. Leave at least 6-inch loops or ends at each outlet for installation of devices or fixtures. Roll up all wires in outlet boxes not for connection to a fixture or device at that outlet, connect together, and tape.

E. Upon completion of cable and wire installation, but before termination to equipment, test each wire for grounds and short circuits. Replace or correct defective wiring.

3.05 SEALING RACEWAY INSTALLATIONS

A. For concrete exterior wall surface above grade, cast raceway or sleeve in wall or core drill wall and hard pack with Non-Shrink Grout. Seal around all penetrations with caulking approved for exterior use. Seal interior of all conduits that enter the building through floor, roof, or outside walls that may carry water into the building. Seal on the end inside the building using duct-sealing mastic, nonhardening compound type, specifically designed for such service. Pack around wires in the conduit.

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B. For exterior surface below grade, cast raceway into wall/floor or use manufactured seal assembly cast in place. *OZ Type FSK* or equal. Change from PVC to steel conduit (couplings or bushings) where necessary to obtain a watertight seal in poured concrete wall or floors. For exterior wall penetrations below grade, install *OZ Type CSB* sealing bushing at interior end of penetrating conduit. Only threaded fittings are permitted in entering conduits ahead of the sealing bushing. Provide for water drainage so no electrical problems will result if seals leak.

3.06 INSTALLATION OF BOXES AND ENCLOSURES

A. The location of all boxes and enclosures shall be coordinated prior to rough-in.

B. Inside of structures, boxes and enclosures shall be recessed unless otherwise noted on the Drawings. Face of box (or extension ring) shall be flush with wall finish, plumb, have all unused openings closed with knockout closures, and accessible.

C. Outside boxes and enclosures shall be mounted on galvanized racks secured to structures or embedded in concrete. If mounted to structures, stand-offs shall be used to provide space between the device and the structure.

D. Care shall be taken with surface mounted boxes in wet location areas and cast type boxes shall be used. Boxes in masonry shall be masonry type, or 4-inch square box with proper mud/tile ring.

3.07 SWITCHES, RECEPTACLES, AND OTHER DEVICES

A. Rigidly fasten each switch, receptacle, or device to the box set plumb with the structure lines and at proper position with the wall or surface to bring receptacle flush with plate or switch handle the proper distance through the plate. Covers, plates, or enclosures shall be of the correct type for the location, box type, and device, installed as required or as called for on the Drawings, and fit tight without gaps or strain.

B. Set switches vertical, with handle operating vertically, with the up position being "ON." Switches and receptacles shall be wired with the wire looped clockwise and fully seated under the head of the terminal; no stab-type connections allowed. Provide bonding wire between receptacle grounding terminal and box (all devices). Plaster ear screws connecting the receptacle frame to the box will not be acceptable for grounding.

C. Set switches 48 inches above finished floor, and receptacles 18 inches above finished floor to the top of the box, unless otherwise noted on the Drawings. Height may vary slightly to accommodate construction. All receptacles or switches in any one room shall be installed at the same height, unless otherwise noted on the Drawings. Devices for special equipment shall be mounted as to be readily accessible.

D. Receptacle devices shall be pigtailed to circuit wiring, allowing continuous feed-through operation. (Do not feed through the device).

3.08 DISCONNECTS

A. All circuit or motor disconnects shall be of the circuit-breaker type (no fuses). Enclosures shall be of the proper type for the intended location or as indicated on the Drawings.

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B. Supply motor or load from individual branch circuit in separate branch conduit, except where otherwise shown.

C. Make all final connections to motors and equipment with flexible seal tight conduit. Provide ground wire to motor frame. Adequately support conduit at each motor or piece of equipment.

D. Manual overload resets shall be coordinated to reset the device without opening the door.

3.09 SUPPORTING DEVICES

A. Provide channels, angles, and trapeze and metal supports where indicated, or as required for the proper support of equipment. Unless otherwise indicated on the Drawings, supports shall be galvanized or stainless steel. Use galvanized fittings, bolts, and nuts. Where welding is necessary, the welds shall be cleaned, given a prime coat of zinc chromate, and finished to match the existing paint in type and color.

B. Support conduits by pipe straps, wall brackets, hangers, or ceiling trapeze and within 2 feet of box, couplings, and each side of offsets or bends. Horizontal and vertical conduit runs shall be supported by 1-hole, heavy-duty, malleable iron straps, clamp backs, or other devices with suitable bolts, expansion shields (where needed), or beam-clamps for mounting to building structure or special brackets. Support flexible conduit within 12 inches of every outlet box or fitting.

C. The use of perforated straps or wire for supporting conduits is prohibited. Fasten with wood screws, or screw nails to wood by toggle bolts on hollow masonry units, by concrete inserts, or expansion steel conduits on steel. Do not weld conduits or pipe straps to steel structures unless specifically indicated.

D. In existing concrete slabs and walls, utilize drilled-in threaded inserts (wedge anchors), installed as recommended by the manufacturer where additional supports are required. Neatly core drill openings where additional sleeves are required.

END OF SECTION 16050

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SECTION 16210
ENCLOSED STANDBY GENERATOR

PART 1 - GENERAL

1.01 SUMMARY

A. This section describes the requirements of the enclosed standby propane powered-electric generator set. The generator set will be new and supplied and installed by the Contractor. All additional materials, connections, and installations required to provide a complete and operative system shall be new and provided by the Contractor.

B. The system shall be built, tested, and shipped by one manufacturer and shall be a package of new and current equipment consisting of:

1. A propane engine driven electric generating set to provide standby power;

2. An engine start-stop control system mounted on the generating set and compatible with an auto-transfer switch; and

3. A sound attenuated enclosure with mounted accessories as specified.

1.02 PARTS AVAILABILITY

The manufacturer shall have been regularly engaged in design and production of generator sets for a minimum of 10 years and have a local authorized dealer who can provide factory-trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration.

1.03 WARRANTY

In addition to that required by the *GENERAL CONDITIONS*, the standby power generation system, furnished completely by the manufacturer, shall be warranteed for a period of 2 years or 400 running hours from the date of acceptance. All parts, travel, and labor shall be covered.

1.04 RELATED WORK

A. *SECTION 16000 - GENERAL ELECTRICAL PROVISIONS*

B. *SECTION 16050 - BASIC MATERIALS AND METHODS*

C. *SECTION 16230 - AUTOMATIC TRANSFER SWITCH*

D. *SECTION 16400 - SERVICE AND DISTRIBUTION*

1.05 SUBMITTALS

A. Provide owner with information required on the City of Tumwater Generator Permit.

B. Provide owner with information required on the Olympic Region Clean Air Agency permit.

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C. Letter of Certification which documents that the proposed engine emissions meet City of Tumwater and State of Washington emission limits for this project installation and application.

PART 2 - PRODUCTS

2.01 GENERATOR

A. A Cummins GGHJ Propane powered Electric Generating Set shall be used as criterion for establishing quality and function. The set shall, as a minimum, be rated for standby service at: 480/277 volts, 3 phase, 125 KW, 60 Hz. with a weatherproof steel enclosure, integral exhaust system, and sound attenuation level 2 with package rating of 75 dBA at 23 feet.

B. Due to agency standardization, no other type of equipment will be approved.

C. Generator Set shall be comprised of the following components and ratings at a minimum:

1. Duty Rating-Standby Power
2. Fuel System: propane liquid withdrawal
3. UL 2200 Listing
4. Cert: Seismic IBC2000, IBC2003, IBC2006, IBC2009, IBC2012
5. Enclosure: Steel with integral exhaust system
6. Sound Attenuation: Level 2, with Exhaust System, 75 dBA at 23 feet.
7. Voltage: 480/277, 3 Phase, Wye, 4 Wire
8. Alternator: 60 Hz, 12 Lead, Upper Broad Range, 105 DegC
9. Genset Control: POWERCOMMAND 2.2
10. Exciter/Regulator: PMG, 3 Phase Sensor
11. Engine Governor: Electronic, Isochronous Only
12. Display Language: English
13. Control Mounting: Rear Facing
14. Stop Switch: Emergency
15. Circuit Breaker: 200A, 3P, 480V, TM, 80%UL
16. CB or EB or TB: Bottom Entry, Left
17. Wind Rating: 150 MPH, Steel Housing
18. Skid-base: Housing Ready
19. Engine Starter: 12 VDC Motor
20. Battery Charging Alternator: Normal Output
21. Engine Cooling: High Ambient Air Temperature
22. Shutdown: Low Coolant Level
23. Extension: Engine Coolant Drain
24. Coolant Heater and vaporizer: 120 Volt Ac, Single Phase
25. Engine Air Cleaner: Heavy Duty
26. Extension: Oil Drain
27. Test Record: Certified
28. Genset warranty: Base, Standby 2 years / 400 hours
29. Battery Rack
30. Battery Engine Starting Battery
31. Battery Charger: 10Amp-12Vdc-120Vac

D. Engine:

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1. Four cycle, full compression ignition, single acting, solid-injection unit, V-type pistons naturally aspirated or turbo charged with after cooling.

2. Fuel supply: Propane liquid (LP liquid).

3. Removable full wet-type cylinder liners of close grained alloy iron, heat treated for proper hardness to obtain maximum life.

4. Capable of operating at idle or light loads for extended periods of time.

E. Complete Engine Fuel System:

1. Include all propane vaporizers, pressure regulators, strainers, and control valves.

2. Plumbed to generator set skid for ease of site connections to the generator set.

3. Flexible fuel lines.

2.06 ACCESSORIES

A. All accessory materials and labor shall be provided by the Contractor for proper operation of the generator as shown on the Drawings. These items shall be new and of the quality specified.

B. Provide a critical silencing muffler sized for the generator supplied, with bellows-type metal flexible exhaust. All integral inside the Generator enclosure.

C. Provide flexible fuel and liquid-tight flexible electrical connections between the unit and points of supply or distribution.

D. Provide a thermostatically controlled water heater for maintaining block temperature of the engine.

E. Provide required batteries, battery enclosure, and 10-amp automatic-float battery charger with constant-voltage regulation, current limiting capability, temperature compensated for ambients from minus 20 °F, and ammeter with battery clamps, leads, and power cord.

2.07 REGULATION

Voltage regulation shall be within plus or minus 1 percent at constant load. The instantaneous voltage dip shall be less than 16 percent of rated voltage when full, 3-phase load, and rated power factor is applied to the alternator. Recovery to stable operation shall occur within 2 seconds. Stable or steady state operation is defined as operation with terminal voltage remaining constant within plus or minus 1 percent of rated voltage. A rheostat shall provide a minimum of plus or minus 5 percent voltage adjustment from rated value.

2.08 ALTERNATOR INSTRUMENT PANEL

The alternator instrument panel shall be wired, tested, and shock mounted on the generating set by the manufacturer of the alternator. It shall contain panel lighting, manual reset, circuit breaker, frequency meter, running time meter, voltage adjusting rheostat, AC voltmeter (indicates all voltages), AC ammeter (indicates current each phase), meter switch, and voltmeter ammeter phase selector with "OFF" position.

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2.09 FUEL STORAGE TANK

Provide piping to the fuel tank for future connection by the fuel tank installer. Refer to WDFW specification DIV 15950 FUEL PIPING. Owner will rent the Propane fuel tank from the propane supplier.

2.10 MUFFLER

The muffler shall be a critical area silencing muffler, integral in Generator enclosure.

PART 3 - EXECUTION

3.01 GENERATOR

The standby power generation set shall be premounted on a steel frame to provide suitable mounting to any level surface. Generator shall have integral isolation between the engine and the skid. The generator set shall be bolted to the concrete foundation for earthquake resistance, with nuts and lockwashers. The system shall be installed as shown on the Drawings and in a neat and workmanlike manner. Lines shall be installed parallel with and at right angles to floor. All final electrical and piping connections to the unit shall be made with flexible connections. Install and connect the battery units to the generator.

3.02 EXHAUST / MUFFLER

Assure that placement of Genset does not result in exhaust fumes infiltrating adjacent buildings, creating a risk of carbon monoxide poisoning to staff or visitors. Modify exterior exhaust piping if necessary.

3.03 FUEL STORAGE TANK

Provide piping to the fuel tank for future connection by the fuel tank installer. Refer to WDFW specification DIV 15950 FUEL PIPING. Owner will rent the Propane fuel tank from the propane supplier.

3.04 TESTING

A. The complete installation shall be checked for procedural and operational compliance by a representative of the system manufacturer's authorized local dealer. The engine lubricating oil and antifreeze, as recommended by the system manufacturer, shall be provided by the generator set dealer. If switchgear and generator sets are furnished by different manufacturers, technical representatives of both manufacturers' authorized dealers shall verify the installation meets requirements. Any deficiencies shall be noted and corrected by the Contractor. The system manufacturer's dealer representative shall be present to assist the Contractor during startup, systems check, adjusting, and any site testing required after the installation is complete.

B. Following installation, tests shall be performed by the system manufacturer's local dealer representative(s) in the presence of the Owner's Engineer or designated appointee. Perform resistive load bank test at the following levels of nameplate rating:

1. 25 percent rating for 30 minutes

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2. 50 percent rating for 30 minutes

3. 75 percent rating for 30 minutes

4. 100 percent rating for3 hours

5. 110 percent rating for 20 minutes

C. After completion of load testing, the system manufacturer's authorized dealer shall provide a complete orientation for the Owner's engineering and maintenance personnel. Topics covered shall include control operation, schematics, wiring diagrams, meters, indicators, warning lights, shutdown system, and routine maintenance. Demonstrate functional capability at site under manual and automatic modes of operation. Verify that all controls work, and that interfaces with automatic dampers, fuel system, and transfer switches are properly operating.

END OF SECTION 16210

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SECTION 16230
AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 SUMMARY

A. Provide a new Automatic Transfer Switch that has been prototype tested, factory built, production tested, of the latest commercial design, together with all accessories necessary for a complete installation as shown on the Drawings and specified herein.

B. Related Work: *SECTION 16210 – ENCLOSED STANDBY GENERATORS*

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. *Cummins* Automatic Transfer Switch (ATS) *OTEC Open Transition* shall be used as criteria for establishing quality and function.

B. ATS shall be produced and distributed by the same manufacturer as the Generator it supplies.

2.02 AUTOMATIC TRANSFER SWITCH CHARACTERISTICS

A. Automatic Transfer Switch (ATS) ratings shall be 300-Amp, 480Y/277 Volt, 3-phase, 4-wire, 60-cycle, 30,000-amp interrupting capacity.

B. ATS enclosure shall be NEMA 3R.

C. ATS shall sense the voltage from all phases to neutral and have both over and under voltage sensing.

D. The ATS shall have a control circuit disconnect switch to disengage the control circuit for manual operation.

E. The ATS shall have *PERMANENTLY* attached operating handles for manual operation and an insulated safety shield protecting the operator from energized parts.

F. The ATS shall have controls that are inherently compatible with the engine generator set.

G. The ATS shall have a program time delay to neutral.

2.03 AUTOMATIC TRANSFER SWITCH ACCESSORIES

A. The following accessories shall be included:

1. Time delay on engine start (TDES) adjustable from 0 to 10 seconds.

2. Time delay on transfer from "Normal" to "Emergency" (TDEN) adjustable 0 to 300 seconds.

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3. Time delay on transfer from "Emergency" to "Normal" (TDEN) adjustable from 0 to 30 minutes.

4. Time delay on Engine Cooldown (TDEC) adjustable from 0 to 30 minutes to allow availability of emergency source in an unloaded condition to allow the engine to cool down before engine shutdown.

5. Provide a door-mounted Operator Control Panel with pushbuttons to *initiate tests*, *override time delays*, and *set exercise time*. Test position shall allow the operator to test the system under load or no-load conditions.

6. Provide door-mounted indicators to indicate switch position and source being monitored.

7. This is an outdoor ATS. The record low temperature was -8°F.

2.03 COMPONENT COMPATABILITY

A. The automatic transfer switch shall be compatible with the engine generator set without changing, adding, or deleting equipment to the existing generator controls.

B. The transfer switch and generator may be made compatible with approval of the Engineer.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

The Transfer Switch shall be installed as shown on the Drawings in accordance with the manufacturer's recommendations and all applicable codes.

3.02 SITE TESTS

Contractor shall ensure that an installation check and building load test are performed by the manufacturer's local representative. The Engineer, regular operators, and maintenance staff shall be notified of the time and date of the site test. The tests shall include automatic startup by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Instruct personnel on proper operation & maintenance.

3.03 MANUALS

Provide (3) bound and digital copies of troubleshooting, maintenance, and shop drawing manuals for the Engineer's use.

END OF SECTION 16230

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SECTION 16430
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 SUMMARY

A. This specification describes the electrical, mechanical, environmental, agency and reliability requirements for three-phase, Variable Frequency Drives (VFD) as specified herein and as shown on the contract drawings.

1.02 RELATED SECTIONS

A. SECTION 16010 - GENERAL ELECTRICAL PROVISIONS

B. SECTION 16050 – BASIC MATERIALS AND METHODS

C. SECTION 16620 – MOTOR STARTERS

D. SECTION 16640 – MOTOR SOFT STARTERS

1.03 REFERENCES

A. The variable frequency drives and all components shall be designed, manufactured and tested in accordance with the latest applicable standards.

1. Institute of Electrical and Electronic Engineers (IEEE)

a. IEEE 519-1992: Guide for harmonic content and control

1) Underwriters Laboratories (UL508C: Power Conversion Equipment)

b. UL

c. CUL

1) National Electrical Manufacturer's Association (NEMA)

d. ICS 7.0: Industrial Controls & Systems for VFD.

1) IEC 61800-2 and –3. EN 50082-1 and –2

e. Fulfill all EMC immunity requirements

B. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1.04 SUBMITTALS - FOR REVIEW/APPROVAL

A. The following information shall be submitted to the Engineer.

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1. Dimensioned outline drawing
2. Schematic diagram
3. Power and control connection diagram(s)

B. Submit four (4) copies of the above information.

1.05 SUBMITTALS-FOR INFORMATION

A. When requested by the Engineer the following product information shall be submitted:

1. Descriptive bulletins
2. Product sheets
3. Harmonic Analysis

1.06 SUBMITTALS-FOR CLOSEOUT

A. The following information shall be submitted for record purposes prior to final payment.

1. Final as-built drawings and information for items listed section in 1.04.
2. Installation information.

1.07 QUALIFICATIONS

A. The supplier of the assembly shall be the manufacturer of the electromechanical power components used within the assembly, such as bypass contactors (when specified).

B. For the equipment specified herein, the manufacturer shall be ISO 9001 certified.

C. The supplier of this equipment shall have produced similar electrical equipment for a minimum period of ten (10) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Variable Frequency Drives shall be on the basis of Eaton PowerXL DG1 Series for function and quality. Products that are in compliance with the specification and manufactured by others will be considered as "Approved Equal" only if pre-approved by the Engineer fourteen (14) days prior to bid date. Alternate suppliers shall submit documentation showing itemized compliance to the specifications and experience specific to the proposed VFD including a list showing details of the installation, application, location, contact name and telephone number of at least 10 users.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

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1.09 OPERATION AND MAINTENANCE MANUALS

A. Five (5) copies of the equipment operation and maintenance manuals shall be provided.

B. Operation and maintenance manuals shall include the following information:

1. Instruction books

2. Recommended renewal parts list

3. Drawings and information required by Section 1.06.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Eaton Corporation

1. The owner (WDFW) specifies Eaton PowerXL DG1 Series Drives in the interest of agency standardization and simplified maintenance. Substitutions will only be considered as detailed in section 1.07(D) of this specification.

2.02 VARIABLE FREQUENCY DRIVES (VFD)

A. Where shown on the drawings, variable frequency drives Variable Torque (VT), shall have the following features:

1. The VFD shall be rated for 480 VAC. The VFD shall provide microprocessor-based control for three-phase induction motors. The controller's full load output current rating shall be based on 40 °C ambient and 3.6 kHz switching frequency and above to reduce motor noise and avoid increased motor losses as standard.

2. The VFD shall be of the Pulse Width Modulated (PWM) design converting the utility input voltage and frequency to a variable voltage and frequency output via a two-step operation. Adjustable Current Source VFD is not acceptable. Insulated Gate Bipolar Transistors (IGBT's) shall be used in the inverter section. Bipolar Junction Transistors, GTO's or SCR's are not acceptable. The VFD shall run at the above listed switching frequencies.

3. The VFD shall have efficiency at full load and speed that exceeds 95%. The efficiency shall exceed 90% at 50% speed and load.

4. The VFD shall maintain the line side displacement power factor at no less than 0.96, regardless of speed and load.

5. The VFD shall have a one (1) minute overload current rating of 110% for variable torque drives.

6. The VFD shall be capable of operating any NEMA design B squirrel cage induction motor, regardless of manufacturer, with a horsepower and current rating within the capacity of the VFD.

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7. Provide an input EMI filter to minimize conducted electrical noise to meet the requirements of IEC 61800-3.

8. The VFD shall limit harmonic distortion reflected onto the utility system to a voltage and current level as defined by IEEE 519 for general systems applications, by utilizing the standard 5% DC link choke with input surge protection with a two coil design integrally mounted in the VFD enclosure

9. Any harmonic calculations shall be done based on the kVA capacity, X/R ratio and the impedance of the utility transformer feeding the installation, as noted on the drawings, and the total system load. The calculations shall be made with the point of common coupling being the point where the utility feeds multiple customers.

10. Total harmonic distortion shall be calculated under worst-case conditions in accordance with the procedure outlined in IEEE standard 519-1992. Copies of these calculations are to be made available upon request. The contractor shall provide any needed information to the VFD supplier three (3) weeks prior to requiring harmonic calculations.

11. VFD to have 100kAIC short circuit withstand rating

12. Include all metal conduit plate and rubber grommets

13. The system containing the VFD shall comply with the 5% level of total harmonic distortion of line voltage and the line current limits as defined in IEEE 519-1992.

14. The VFD shall be able to start into a spinning motor (flying start). The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.

15. Standard operating conditions shall be:

    a. Incoming Power: Three-phase, 480 Vac (+10% to -15%) and 50/60 Hz (+/-5 Hz) power to a fixed potential DC bus level.

    b. Frequency stability of +/-0.05% for 24 hours with voltage regulation of +/-1% of maximum rated output voltage.

    c. Speed regulation of +/- 0.5% of base speed.

    d. Load inertia dependant carryover (ride-through) during utility loss.

    e. Insensitive to input line rotation.

    f. Humidity: 0 to 95% (non-condensing and non-corrosive).

    g. Altitude: 0 to 3,280 feet (1000 meters) above sea level without de-rating

    h. Ambient Temperature: -10 to 40 °C with de-ratings up to 60 °C

    i. Storage Temperature: -40 to 70 °C.

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16. Diagnostic Features

    a. Fault History

        1) Record and log faults

        2) Indicate the most recent first, and store up to 30 faults with day and time stamp

17. Features to be included in the VFD:

    a. HMCP or thermal magnetic breaker to provide a disconnect means. Operating handle shall protrude through the door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. Door handle interlock can be defeated by qualified maintenance personnel.

    b. *THREE CONTACTOR BYPASS* shall include a drive input disconnect, a VFD input isolation contactor, bypass contactor and a VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor over-current relays. The complete bypass system BYPASS-OFF-VFD selector switch and Inverter/Bypass pilot lights shall be packaged with the VFD. The unit shall be configured for Manual bypass operation in the event of a failure of the VFD.

    c. AC output contactor to provide a means for positive disconnection of the drive output from the motor terminals.

    d. Fused space heaters with thermostat for oversize enclosures to minimize condensation potential upon drive shutdown.

    e. Laminated plastic or steel nameplate engraved with user's identifying name or number for oversize enclosures.

    f. 120 VAC or 24VAC control to allow VFD to interface with remote dry contacts.

    g. Motor over-current relay to provide sensing of a given level of load current.

18. Keypad

    a. The keypad shall include a Local/Remote pushbutton selection. Both start/stop source and speed reference shall be independently programmable for Keypad, Remote I/O, or Field Bus.

    b. Upon initial power up of the VFD, the keypad shall display a start up guide that will sequence all the necessary parameter adjustments for general start up.

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c. Frequently accessed VFD programmable parameters shall be adjustable from a digital operator keypad located on the front of the VFD. The VFD shall have a 3 line alphanumeric programmable display with status indicators. Keypads must use plain English words for parameters, status, and diagnostic messages. Keypads that use only alphanumeric code and tables are not acceptable. Keypads shall be adjustable for contrast with large characters easily visible in normal ambient light.

d. The navigation interface shall include four independent direction navigation keys up, down, left and right with a center "OK" key. The interface keypad shall include additional independent keys for "Local/Remote", "Back/Reset", "Start", "Stop". Include two additional soft keys that that allow for menu shortcuts.

e. The interface keypad shall include three independent status LEDs. The three are "Remote", "Run", and "Fault".

f. The display is a multi-line LED backlight display.

g. Keypad shall be removable with Ethernet communications for remote mounting

h. The keypad must serve as a Copy/Paste module that can hold two sets of parameters

i. The operator shall be able to scroll through the keypad menu to choose between the following screens:

1) Parameters
2) Keypad control
3) Active faults
4) Fault history
5) System menu
6) Expander boards
7) Monitor
8) Operate menu

19. The VFD keypad shall be capable of displaying the following monitoring functions at a minimum:

a. Output frequency

b. Frequency reference

c. Motor speed

d. Motor current

e. Motor torque

f. Motor power

g. Motor voltage

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h. DC-bus voltage

i. Unit temperature

j. Calculated motor temperature

k. Voltage level of analog input

l. Current level of analog input

m. Digital inputs status

n. Digital and relay outputs status

o. Analog Input

20. Protective Functions

a. The VFD shall include the following protective features at minimum:

1) Over-current
2) Over-voltage
3) Inverter fault
4) Under-voltage
5) Input phase loss
6) Output phase loss
7) Under-temperature
8) Over-temperature
9) Motor stalled
10) Motor over-temperature
11) Motor under-load
12) Logic voltage failure
13) Microprocessor failure

21. The VFD shall provide ground fault protection during power-up, starting, and running. A VFD with no ground fault protection during running is not acceptable.

22. On-board Communications

a. The VFD shall include the following communication as standard. Ethernet I/P, Modbus TCP, Modbus RTU, BACnet MS/TP

b. The VFD shall have the following communication protocols as an optional card. Profibus DP, CANopen, Devicenet, Profinet, Smartwire DT, Lonworks.

23. Input/Output

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a. The VFD shall include the follow as standard:

1) Eight (8), 24VDC digital input as standard
2) One (1), open collector 24VDC digital output
3) Two (2) 4 to 20mA analog inputs
4) Two (2) 4 to 20 mA analog outputs
5) Three (3) dry relay contacts rated for 250VAC at 2A or 250VDC at 0.4mA

b. The VFD shall offer the following optional expansion cards

1) Three (3) digital inputs and three (3) digital outputs
2) One (1) isolated analog input and two (2) analog outputs
3) Three (3) dry contact relay outputs
4) Three (3) RTD inputs
5) Six (6) digital inputs rated for 240VAC

c. All field inputs and output connections to the interface board shall use quick-connect terminals

d. All input/output are field programmable

24. Circuit boards

a. All circuit boards shall be conformal coated as standard for moisture and temperature protection

25. Harmonic Mitigation

a. Provide an integrated 5% DC link choke. External choke is not acceptable. The choke shall be a two coil design. DC choke shall include input surge protection.

26. EMI Filter

a. Provide integrated EMI filter. Filter shall meet IEC/EN 61800-3 EMC Category 2.

b. Filter mounting is disconnect able by removing a single screw for compatibility with corner grounded systems and IT systems

27. Real time clock

a. VFD software shall include a real time clock function for a day and time stamp of fault occurrence, start time stamp, stop time stamp, and operating hours.

b. Time clock to include battery back-up

28. Energy Control

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a. VFD software shall include energy optimization algorithm. The software algorithm shall compare output voltage to the motor load. The output voltage is optimized to reduce the motor core losses and maintain a high enough voltage to prevent the motor from becoming unstable.

b. Includes onboard energy savings calculator that allows local kW cost

29. Safe Torque Off

a. VFD shall include safe torque off where IGBTs can be directly de-energized. Safe torque off shall be SIL1 certified (IEC/EN 61800-5-2 and DIN EN ISO 13849 Category 1, Level

30. Cold Weather Functionality

a. VFD shall have the ability to warm IGBTs for starting to a temperature of -30°C.

31. VFD Software

a. Manufacturer to include programming and monitoring configuration software as no extra charge

b. Software applications to include Standard, Multi-Fan and Pump, Multi-PID and Multi-purpose

PART 3 - EXECUTION

3.01 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.

1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.

2. After all tests have been performed, each VFD shall undergo a burn-in test. The drive shall be burned in at 100% inductive or motor load without an unscheduled shutdown.

3. After the burn-in cycle is complete, each VFD shall be put through a motor load test before inspection and shipping.

B. The manufacturer shall provide three (3) certified copies of factory test reports.

3.02 INSTALLATION

A. VFD Control Cabinets shall be assembled by a certified UL / ETL panel shop with current licensing for self-labeling of all assemblies. All components incorporated in the system shall have appropriate listings per WAC regulations.

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B. Field installed VFD shall be installed by WA state certified electricians qualified to perform the required work. All field wiring and terminations shall be permitted and inspected by the AHJ, and meet all applicable NEC and WAC codes.

3.03 FIELD QUALITY CONTROL

A. Provide the services of a qualified manufacturer's employed Field Service Engineer to assist the Contractor in installation and start-up of the equipment specified under this section. Field Service personnel shall be factory trained with periodic updates and have experience with the same model of VFD on the job site. Sales representatives will not be acceptable to perform this work. The manufacturer's service representative shall provide technical direction and assistance to the Contractor in general assembly of the equipment, installation as specified in manufacturer's installation instructions, wiring, application dependant adjustments, and verification of proper VFD operation.

B. The Contractor under the technical direction of the manufacturer's service representative shall perform the following minimum work.

1. Inspection and final adjustments.

2. Operational and functional checks of VFD and spare parts.

3. The contractor shall certify that he has read the drive manufacturer's installation instructions and has installed the VFD in accordance with those instructions.

C. The Contractor shall provide three (3) copies of the manufacturer's field start-up report before final payment is made.

3.04 MAINTENANCE / WARRANTY SERVICE

A. Warranty to commence 24 months from the date of start-up, not to exceed 36 months from the date of shipment, and include all parts, labor, and travel time.

3.05 FIELD TESTING

A. Optional field testing

1. The VFD manufacturer shall perform harmonic measurements at the point where the utility feeds multiple customers (PCC) to verify compliance with IEEE519-1992. A report of the voltage THD and current TDD shall be sent to the engineer. The contractor shall provide labor, material, and protection as needed to access the test points. The readings shall be taken with all drives and all other loads at full load, or as close as field conditions allow.

3.06 TRAINING

A. The Contractor shall provide an onsite training session for the owner's representatives on a normal workday. Schedule determined by the owner. Training and instruction time shall be in addition to that required for start-up service.

B. The manufacturer's qualified representative shall conduct the training.

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C. The training program shall consist of the following:

1. Instructions on the proper operation of the equipment.
2. Instructions on the proper maintenance of the equipment.

END OF SECTION 16430

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SECTION 16480
MOTOR STARTERS

PART 1 - GENERAL

1.01 SUMMARY

This section includes all motor switches, combination motor starters, manual motor starters, motor heaters, control circuits, and other related devices.

PART 2 - PRODUCTS

2.01 MANUAL STARTING SWITCH

Motor starters for fractional horsepower, single-phase motors operating on 120/240-volt grounded neutral systems shall, as a minimum, consist of a single-pole magnetic conductor or quick make and brake toggle action manual motor starting switch of the proper size, mounted in an enclosure suitable for the location as indicated on the Drawings. Additional items, control relays, pilot devices, and indicating lights shall be supplied as shown. Acceptable products for obtaining quality and function are *Square "D" brand electrical products.*

2.02 COMBINATION MOTOR CONTROLLERS

A. For 3-phase motors up to 7 ½ horsepower, full-voltage, non-reversing, combination 3-phase motor controllers shall be provided at the locations shown on the Drawings. Each controller shall be of proper *NEMA* size required for load served and:

1. Be complete with adjustable, instantaneous-trip circuit breaker (*Square "D" Mag-Gard Class 680*) with lockable handle and defeatable cover interlock.

2. Contain a 3-pole magnetic contactor equipped with 3 quick-trip, overcurrent heaters of the manual reset type (*Square "D" Class 8536*).

3. Include a 120-volt control circuit transformer derived from within the controller of sufficient VA capacity to power all control circuit elements fed from the control circuit transformer, plus 50 VA minimum spare capacity.

4. On outdoor starters: have an external ON-OFF key-operated selector switch with key removable in any position.

5. Be installed in an oversized enclosure designed with extra space for mounting of all auxiliary equipment. Provide NEMA enclosure rated as shown on drawings.

6. Provide an additional auxiliary contact N.O., closed when energized.

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PART 3 - EXECUTION

3.01 INSTALLATION

A. Starters shall be rigidly mounted and secured. Support by conduit shall not be permitted. Where mounted on tanks that may overflow, stand-offs or struts will be required to space the units a minimum of 3 inches from the tank wall._If mounted in damp areas, stand-offs will be required to space the units a minimum of 1 inch from the back surface for air circulation. Where installed on freestanding racks, racks shall be of galvanized construction.

B. Individual starters shall be mounted with their tops at 6 feet above finished grade unless otherwise noted on Drawings. Consult with the engineer before mounting the bottom of the enclosure less than 24" above grade.

C. Wiring shall be neatly bundled and tied after complete installation and all wiring shall be properly identified and numbered according to the wiring control schematic.

3.02 IDENTIFICATION

A. Starters shall be identified as to device and use via engraved, laminated nameplates with black ¼-inch letters on a white background affixed to the device by stainless steel screws or rivets.

B. Motor nameplates shall be checked for full load current rating and allowable temperature rise to determine correct overload thermal units for each motor.

END OF SECTION 16480

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SECTION 16500
LUMINAIRES

PART 1 - GENERAL

1.01 SUMMARY

A. Provide the lighting system identified herein and on the drawings to obtain a complete and operational system.

B. Furnish lighting fixtures of the types, sizes, and finish as listed on the lighting schedule and on the Drawings. Fixtures shall be new, complete assemblies constructed to ensure full life of components, and minimize amplification and transmission of component noise.

1.02 RELATED WORK

SECTION 16050 BASIC MATERIALS AND METHODS

PART 2 - PRODUCTS

2.01 MATERIALS

A. Substituted fixtures must be of equal or better quality than the specified fixtures including general appearance, photometric characteristics, operating temperatures, durability of finish and general quality. The Engineer shall approve all substitutes in writing.

B. All fixtures shall be as specified or substituted in writing and suitable for the conditions of use.

C. Luminaires shall be factory assembled as LED fixtures, unless otherwise specified.

D. Breakers used as switches shall be listed for the purpose.

PART 3 - EXECUTION

3.01 LIGHTING FIXTURES - GENERAL INSTALLATION

A. Size, orientation, and mounting height from finished grade to the bottom of fixture shall be as indicated on the Drawings. Verify mounting provisions prior to ordering fixtures. Fixtures shall be *UL* listed for the location, environment, and application in which they are installed.

B. Lighting shall be as shown in the lighting schedule and on the Drawings. Minor relocations, to avoid conflicts in construction, shall be permitted with approval from the Engineer.

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C. Fixtures shall be securely mounted to the structure and not depend upon the conduit system for support. Coordinate or provide backing support from structure for fixture mounting prior to finishes. Use of drywall anchors for sole support shall be done with Engineer approval only.

D. For Luminaires mounted on corrugated metal siding, coordinate mounting prior to interior finishes. Provide reinforcement/backing as needed. Wall-Packs shall be mounted with nuts and bolts or wood screws into backing boards. Fixtures shall NOT use sheet metal screws into siding as sole support. Install fixtures so they sit evenly on corrugation and do not flatten or dent the siding. Mounting method shall adequately support the Luminaire without sagging or siding deflection. Seal openings and penetrations in fixture and siding with silicone exterior caulking. Fixture shall be fully openable without sealer, caulking, or obstructions in the way. *FAILURE to adequately support or seal wall-mounted Luminaires will require Contractor to remove and replace them at no cost to the Owner. This may include removal and replacement of some interior finishes at the Contractor's expense.*

E. Mount Luminaires square with structure, walls, or furniture as shown. Align rows of fixtures for visual symmetry. Install wall-mounted fixtures plumb and level.

F. All fixtures shall be properly grounded and suitable for the locations and condition of use, and installed per the manufacture's installation instructions.

G. Make all final fixture adjustments and settings under the direction of the Architect/Engineer prior to the completion of the project. Fixtures shall be aimed or installed to achieve the lighting pattern for which the fixture is designed and purpose intended.

END OF SECTION 16500

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