

DIVISION 26 – ELECTRICAL SPECIFICATIONS



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SECTION 26 05 00 – GENERAL ELECTRICAL

PART 1 GENERAL

1.01 DESCRIPTION

- A. The General Conditions, Supplementary Conditions, and related work in other Sections apply for all work in Section 26.

1.02 SCOPE OF WORK

- A. This section specifies general requirements for electrical work. Detailed requirements for specific electrical items are specified in other sections, but are subject to the general requirements of this section. The electrical drawings and schedules included in this project manual are functional in nature and do not specify exact locations of equipment or equipment terminations. It is the intent of this Section of the Specifications and the accompanying drawings to describe and provide for the furnishing, installing, testing and placing in satisfactory and fully operational condition all equipment, materials, devices and necessary appurtenances to provide a complete electrical system, together with such other miscellaneous installations and equipment hereinafter specified and/ or shown on the drawings. The work shall include all materials, appliances and apparatus not specifically mentioned herein or shown on the drawings, but which are necessary to make a complete, fully operational installation of all electrical systems shown on the drawings or described herein. Equipment and devices furnished and installed under other Sections of this specification shall be connected under this Section. The drawings and specifications are complementary and what is called for in either is binding as if called for in both.
- B. This project may include installation of packaged equipment system(s) or sub-system(s) that will require coordination between the Contractor and the manufacturer to determine the detailed installation requirements. The Engineer has shown general installation information for these systems based on the best information available at the time of design. Where indicated on the drawings to ‘provide a complete and operational system’ the Contractor shall provide all materials, installation, and coordination with the manufacturer so the equipment is installed and operates in a satisfactory manner. Minor changes in equipment locations, quantity of terminations or wires, junction boxes, conduit, etc shall be included in the Contract price.
- C. See all other Sections of these specifications for work in other areas and disciplines related to this project.

1.03 GENERAL DESCRIPTION OF ELECTRICAL WORK

- A. The Contractor shall provide all labor, material, tools, equipment and services required to complete the furnishing, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical equipment, devices and components as indicated and implied by the drawings and specifications. General descriptions include:
 - 1. Complete the procurement, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical devices, components, accessories and

equipment that is not shown or specified but which is nonetheless required to make the systems shown and specified function properly.

2. Install all equipment so it shall be readily accessible for maintenance. Installations shall have electrical clearances in accordance with NEC and shall be installed in locations that will provide adequate cooling.
3. Check electrical equipment prior to installation so that defective equipment is not installed.
4. Provide field services of qualified technicians to supervise and check out the installation of the equipment, to supervise and check out interconnecting wiring, to conduct start-up of operation of the equipment, and to correct any problems that occur during start-up.
5. Provide circuit breakers, conduit, wire and installation for all items that require electrical power.

1.04 PROJECT DESCRIPTION

- A. This project shall consist of the construction of process improvements and facility improvements at the Eastsound Waste Water Treatment Plant (WWTP) located on Orcas Island, WA.
- B. The major electrical work shall include, but not limited to:
 1. Selective electrical demolition of existing electrical service area.
 2. Upgrade of existing utility service from 208Y/120V to 480Y/277V.
 3. New standby diesel generator and service rated Automatic Transfer Switch.
 4. New power distribution including panels, raceway, wiring, disconnects, etc.
 5. Lighting and lighting controls.
 6. Motor Control Center with power distribution, motor starters and Variable Frequency Drives (VFD's) as shown on the drawings.
 7. PLC based control panel with operator interface in Blower building,
 8. PLC based control panel for Influent pump station.
 9. Instrumentation including as shown on the drawings including level transducers, float switches, pressure transmitters, DO sensors, gas sensors, door switches, smoke detectors, flow meters and other devices as shown on the drawings.
 10. New Supervisory Control and Data Acquisition computer system, as specified.
 11. Programming and commissioning of all PLC, operator interface and SCADA system hardware and software shall be provided by the System Integrator.

12. Installation of packaged equipment and treatment systems.
13. All other electrical work as shown on the drawings.

1.05 ELECTRICAL CONTRACTOR MINIMUM QUALIFICATIONS

- A. The Electrical Contractor shall have a minimum 5 years of experience with having performed similar construction installations.
- B. Provide a summary of qualifications with the bid form, including Owner, project description, and summary of electrical equipment manufacturer and ratings that shows similar project experience.

1.06 CODES AND REGULATIONS

- A. The electrical systems shall be installed based on the following current Standards:
 1. NFPA 70 - National Electrical Code - current version as adopted by Washington State Department of L&I.
 2. Washington Administrative Code (WAC) chapter 296-46B.
 3. Building Codes - International Conference of Building Officials as adopted and amended by the Local Jurisdiction.
- B. The Contractor is required to familiarize himself with the detailed requirements of these standards and any local codes and ordinances as they affect the installation of specific electrical systems.
- C. Identification of Listed Products
 1. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.
 2. Equipment listed/labeled by an NRTL shall be as dictated by the latest printing of the Electrical Testing Laboratories Accreditation Report available from the State of Washington Department of Labor and Industries, Electrical Inspection Division. Any NRTL listing/labeling shall be as accepted by the local authority having jurisdiction.
 3. When a product is not available with a testing laboratory listing for the purpose for which it is to serve, the product may be required by the inspection authority to undergo a special inspection at the manufacturer's place of assembly. All costs and expenses incurred for such inspections shall be included in the original contract price.
 4. All skid mounted and packaged equipment systems shall be labeled in accordance with the requirements of the State of Washington Department of Labor and Industries, Electrical Inspection Division.

5. Where field modifications require field inspection for listing/labeling, the Contractor shall be responsible for all field inspection fees for listing/labeling of all final modified electrical assemblies.

D. Thermal ratings of equipment terminations

1. All materials shall conform to the National Electrical Code Article 110-14C. Wiring and circuit breakers on this project are designed for 75 deg C operation above 100 amperes; 60 deg C for 100 amperes and below.
2. All products furnished on this project shall have electrical terminations rated for 60 deg C for ampacities of 100 amperes and below, and rated for 75 deg C for ampacities above 100 amperes.

1.07 PERMITS AND FEES

- A. The Contractor shall obtain and pay for all licenses, permits and inspections required by laws, ordinances and rules governing work specified herein.
- B. The Contractor shall arrange for inspection of work by the inspectors and shall give the inspectors all necessary assistance in their work of inspection.

1.08 COORDINATION

- A. The Contractor responsible for accomplishing Section 26 work shall coordinate his work with that of the other Contractors and/ or other trades doing work on the project and shall examine all drawings and specifications of other trades for construction details and necessary coordination.
- B. Obtain submittals and shop drawings of all equipment with electrical connections furnished under other Sections of the specifications. Provide all wiring in accordance with requirements indicated. Advise the Engineer of any changes which may affect the contract price.
- C. Special attention is called to the following items and all conflicts shall be coordinated prior to installation:
 1. Location of pipes and equipment so that all electrical equipment, lighting fixtures and other electrical outlets and equipment are clear from and in proper relation to these items.
 2. Recessing and concealing electrical materials in CMU walls, concrete construction and similar construction methods.
 3. Electrical characteristics (HP, KVA, voltage, phase) of actual equipment furnished under other Sections being different from that shown on the electrical drawings.
- D. The Contractor will not be paid for relocation of work, cuttings, patching and finishing required for work requiring reinstallation due to lack of coordination prior to installation.

1.09 SITE FAMILIARIZATION

- A. The Contractor shall become familiar with all features of the site which may affect the execution of the work prior to submitting a bid.
- B. The Contractor shall take all field measurements necessary for the work and shall assume full responsibility for their accuracy.
- C. The Contractor shall take full responsibility for locating and avoiding all substructures and utilities. Any damage to existing equipment or utilities shall be repaired or replaced by the Contractor at the Contractors expense.

1.010 AREA CLASSIFICATIONS

- A. The following classification of areas shall be used as a reference in determining application of material covered by this Section unless specifically shown otherwise on the drawings.
 - 1. Outdoor, Damp or Corrosive Areas:
 - a. Raceways shall be Rigid Galvanized Steel (RGS). Conduit entrances shall be threaded and fittings shall have gasketed covers. Threaded fastening hardware and rods shall be galvanized or stainless steel. Raceway supports such as channel, clamps, and brackets shall be galvanized steel, stainless steel or aluminum. Panels and boxes shall be NEMA 4X, 3R or as shown on the drawings. Enclosures shall be mounted 1 inch from walls to provide an air space unless specifically shown otherwise. Device boxes shall be cast, copper free aluminum.
 - 2. Below Grade Areas:
 - a. Conduits shall be Schedule 40 PVC, or as indicated on the drawings. Sweeps shall be RGS. Transitions from below to above-grade areas in damp areas shall be PVC coated RGS.
 - 3. Hazardous areas: All areas indicated as Hazardous Areas on drawings, or as classified by NFPA 820.
 - a. Raceways, junction boxes and sealing fittings shall be installed in accordance with NFPA 70, article 500.
 - 4. General Purpose Areas: All other areas not described above
 - a. Raceways shall be RGS. Raceways concealed in walls or ceilings for general purpose lighting and receptacle circuits may be EMT. Exposed boxes shall be NEMA 12. Concealed boxes may be NEMA 1.

1.011 CONTRACT DRAWINGS

- A. Raceways, boxes, and ground connections are shown diagrammatically only and indicate the general character and approximate location. The drawings do not necessarily show the total number of raceways or boxes for the circuits required, nor are the locations of indicated runs intended to show the actual routing of the raceways. The Contractor shall furnish, install and place in satisfactory condition all raceways, boxes, conductors, and connections and all

other materials required for the electrical systems shown or noted in the contract documents to be complete, fully operational and fully tested upon completion of the project.

- B. The drawings do not show all requirements of the specifications. The drawings and specifications are complimentary and what is called for (or shown) in either is required to be provided as if called for in both.
- C. The horsepower of motors and apparatus wattages shown on the drawings are estimated requirements of equipment furnished under other Sections of this contract and bid shall be based on these sizes. Overload elements shall be provided to suit actual equipment nameplate current. Advise Engineer of any equipment changes or substitutions affecting electrical systems.
- D. Any minor changes in the location of the raceways, outlets, boxes, devices, wiring, Utility equipment, etc., from those shown on the drawings shall be made without extra charge.
- E. When inserts or sleeves for outlet boxes, conductor, pump cables and/ or raceways are required, Contractor shall provide and shall fully coordinate the installation with other trades.
- F. Electrical drawings shall be used for construction of electrical systems only. The electrical drawings do not show construction features of other trades.

1.012 ELECTRICAL SUBMITTALS

- A. Electrical submittals shall be submitted in electronic .pdf format, labeled with the project and Contractor's name.
- B. The files shall include an index showing each product being submitted. Submittals shall be clearly identified per the electrical specifications by section and paragraph or equipment.
- C. Each equipment submittal sheet shall clearly indicate the individual equipment name and part number. Submittals shall include:
 - 1. Manufacturer's name, address, and telephone number
 - 2. Trade name, catalog model or number, nameplate data and size clearly indicated
 - 3. Layout dimensions, capacity, project specification and paragraph reference
 - 4. Local manufacturers representative
- D. Submittals shall be largely complete prior to the first submittal. Long lead items may be submitted separately. Each item shall be clearly marked and provided with adequate sales and technical information to clearly show conformance with all aspects of the specification. Packages not provided as described above or largely incomplete shall be returned to the Contractor, without review or comment.
- E. The Contractor shall ensure that the material being proposed conforms to the Contract requirements. In the event of any variance, the Contractor shall state specifically which portions vary and shall request a variance in writing.

- F. The Contractor shall certify that all furnished equipment can be installed in the spaces allocated. Any costs for modifications to door openings etc required to move equipment to the final locations shall be the responsibility of the Contractor.
- G. The Contractor shall provide shop drawings in .pdf format scaled for 11" x 17" paper, and shall be scaled using standard engineering or architectural scales. Wiring diagrams shall identify circuit terminals, and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment.
- H. Failure to submit a specified item does not relieve the Contractor from meeting the requirements of the Specification.
- I. The Engineer will review the original submittal and one re-submittal on each item. Subsequent submittal reviews shall be conducted at the Contractor's expense. The Contractor shall be billed at the Engineer's current hourly rates for these subsequent submittal reviews.

1.013 EXISTING SYSTEMS

- A. Prior to bidding, the existing site, existing site electrical systems and systems adjacent to the work shall be investigated thoroughly.
- B. Any damage resulting from performance of work under this contract shall be repaired to assure continuing operation and integrity during and at completion of the project a no increase in contract cost.
- C. Any existing wiring serving devices to remain in service and which is interrupted by work performed under this contract shall be rerouted to maintain circuit continuity.
- D. Contractor shall assume responsibility for unscheduled interruptions and expedient repair.
- E. The Contractor shall inspect the existing systems prior to bidding and shall make his own judgment as to the work required to provide a complete installation within the intent of the contract documents.

1.014 DEMOLITION WORK

- A. All demolition work required under this contract is not shown on the drawings.
- B. The Contractor shall inspect the existing sites and installations prior to bidding and shall make his own judgment as to the work required to provide complete demolition as shown or within the intent of the contract documents.
- C. Existing equipment, systems, and materials removed during demolition shall be made available for his inspection and decision as to whether the Owner will retain possession. Items selected for retention shall be turned over to the Owner. These items shall be delivered to a location on the premises selected by the Owner.
- D. All material not selected for retention by the Owner and debris shall be legally disposed of by the Contractor.

1.015 CONSTRUCTION POWER

- A. The electrical contractor shall provide a dedicated electrical service for construction power. This includes power for construction equipment, job trailer, and any other construction power needs.
- B. The coordination with the serving electrical utility and all associated costs for the temporary construction power equipment and installation shall be provided and paid for by the Contractor.
- C. The Contractor shall pay the for the energy costs as billed by the utility on the construction power meter.

1.016 FACILITY DOWNTIME LIMITATIONS

- A. The work for this project is at an existing operational wastewater treatment facility. Contractor shall maintain power to the facility at all times during construction.
- B. Power interruptions will be required during the upgrade of the electrical service. A minimum of one week notification to the Eastsound Sewer and Water District is required prior to any utility service disruption.
- C. Contractor must provide all required temporary equipment (power generator, pumps, piping, etc.) and submit a schedule and written plan for all wastewater treatment plant disruptions that will last longer than 20 minutes. The plan shall require written approval by the Owner and Engineer prior to the service disruption.

1.017 RECORD DRAWINGS

- A. The Contractor shall record the actual electrical system installation on a set of prints kept readily available at the project during construction. These prints shall be used for this purpose alone. Accurately locate with exact dimensions all underground and under slab raceways and stub-outs. At the completion of the work, Contractor shall furnish the Engineer a set of record drawings and the set of markups. Final payment to the Contractor will not be authorized until these prints have been submitted to and accepted by the Engineer. The contractor shall maintain one set of record drawings at the job showing any deviations in the electrical systems from the original design.
- B. Markings shown on the drawings shall conform to the following color coding conventions:
 - 1. Red - Additions or changes showing placement different than shown on the original drawings
 - 2. Green - Deletions or modifications depicting placements different than shown on the original drawing
 - 3. Blue - Notes and Dimensional data showing exact placement of concealed or buried equipment, raceways, etc.

1.018 WARRANTY

- A. The Contractor shall guarantee all work installed under this specification. He shall repair or replace, at his own expense, defective work, materials or parts which are identified within one year after final acceptance.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials must be new, free from defects and not less than the quality herein specified.
- B. Each type of materials furnished shall be of the same make and shall be of the standard products or manufacturers regularly engaged in the production of such materials and shall be the manufacturer's latest standard design.
- C. All materials and equipment installed shall have been tested and listed by Underwriters Laboratories or other approved testing organization and shall be so labeled unless otherwise permitted by the Code Inspector (AHJ).

2.02 NAMEPLATES

- A. Nameplates shall be provided on all electrical devices. This includes motor control equipment, MCC buckets, control stations, junction boxes, panels, motors, instruments, switches, indicating lights, meters, and all electrical equipment enclosures.
- B. Nameplates shall be made of 1/16" thick machine engraved laminated phenolic having engraved black filled letters not less than 3/16" high on white background.
- C. Warning nameplates shall be provided on all panels and equipment which contain multiple power sources or which may have energized circuits with the main disconnecting means in the off position. Lettering shall be white on red background.
- D. All nameplates shall be secured to equipment with stainless steel screws or fasteners. Epoxy glue may be used where fasteners are not practical as determined by the Engineer.

2.03 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The Contractor shall prepare O&M manuals for all equipment furnished under Section 26 of the specifications.
- B. The information included must be the exact equipment installed. Where sheets show the equipment installed and other equipment, the installed equipment shall be neatly and clearly identified on such sheets.
- C. The O&M manuals shall contain all the information needed to operate and maintain all systems and equipment provided in the project. It shall be presented and arranged in the logical manner for efficient use by the Owner's operation personnel. The information provided shall include but not be limited to the following:
 - 1. Equipment manufacturer, make, model number, size, etc.
 - 2. Equipment nameplate data.

3. Description of system configuration and operation including component identification.
 4. Dimensional and performance data for specific unit provided.
 5. Manufacturer's recommended operation instructions.
 6. Manufacturer's recommended lubrication and servicing data.
 7. Complete parts list including reordering information and recommended spares. Parts lists shall give full ordering information assigned by the original parts manufacturer.
 8. Shop drawings and wiring diagrams.
- D. Wiring diagrams for each system shall be complete drawings for the specific system installed under the contract.
- E. The information contained in the manuals shall be grouped in an orderly arrangement by specification index. The manuals shall be bound in a hard cover binder and tabbed with an index. O&M manuals shall not exceed 5" thick. Provide two or more volumes if required. The covers shall be imprinted with the name of the job, Owner, Engineer, Electrical Engineer, Contractor and year of completion. Hard covers and literature contained may be held together with screw post bindings.
- F. A preliminary copy, complete, except for the bound cover, shall be submitted 30 days prior to completion of the project for checking and review. The quantity of manuals shall be as indicated in the General Conditions, but shall not be less than (3) complete sets.

2.04 HOUSEKEEPING PADS

- A. Provide a concrete housekeeping pad under each floor mounted motor control center and other floor mounted electrical equipment. Pad shall be 3" wider on both ends than base of equipment mounted on it. Minimum height is 3".

PART 3 EXECUTION

3.01 STORAGE AND HOUSEKEEPING

- A. The Contractor shall store all electrical equipment in a dry environment free from dust, moisture, sprays or vapors which may be detrimental to their new condition. After installation of equipment, the Contractor shall take care to protect all equipment from all dust, moisture, paint and other sprays, and harmful vapors.
- B. The premises shall be kept free of accumulated materials, rubbish and debris at all times. Surplus material, tools and equipment must not be stored at the job site. Upon completion of the project, all equipment and fixtures shall be cleaned and in proper condition for their intended use.

3.02 SCHEDULING WORK WITH UTILITIES

- A. The Contractor shall be fully and completely responsible for all scheduling and coordination with the Utility companies, including the electrical utility provider, Orcas Power and Light Cooperative (OPALCO).
- B. The Contractor shall coordinate and schedule power outages, power service for operation and construction, telephone and power service as required by the facility prior to Certificate of Occupancy.

3.03 CONTRACTOR / UTILITY INTERFACE RESPONSIBILITIES

- A. The electrical utility providing service to these facilities is Orcas Power and Light Cooperative (OPALCO). The Contractor shall comply with all Utility company standards and Utility requirements.
- B. All Utility company charges for the new service will be paid by the Owner.
- C. The division of responsibilities stated below has been determined by coordination with the Utility, and shall be confirmed by the Contractor prior to bid. The division of responsibility for installation tasks shall be coordinated with the Utility at the time of construction.
- D. Coordinate demolition of existing equipment and services with the Utility. Refer to Contract Documents for additional demolition requirements.
- E. The Contractor shall provide the following service and material for the new 480Y/277V three phase service.
 - 1. Provide new complete secondary underground service, including conduit and conductors, from the existing transformer pad location to the CT enclosure, new Service Rated ATS panel, and new 400 amp distribution panel.
 - 2. Install warning tape for underground electrical utilities.
 - 3. Provide new 480V CT enclosure, landing pads, mounting rack, and meter bases per Utility requirements.
 - 4. Demolition of existing 208V electrical service including secondary raceway and conductors, CT enclosure, meter base, Generator and ATS.
 - 5. Temporary power provisions to limit facility downtime to 20 minutes or less.
 - 6. All other materials and construction shown on the Drawings.
- F. The Utility will provide the following service and materials:
 - 1. Primary Power
 - a. Remove existing 208V Utility transformer from existing concrete pad.
 - b. Install new 480V Utility transformer on existing concrete pad.
 - c. Primary conductor and installation (re-use existing).

d. All primary terminations.

2. Secondary Power

- a. Provide meter in Contractor-provided meter base.
- b. Provide CT's in Contractor-provided CT enclosure.
- c. Terminate Contractors' secondary conductors at transformer.

G. Service equipment shall be listed and labeled by UL as "Suitable for Use as Service Equipment".

3.04 TESTS

- A. The Contractor shall conduct testing for installed feeder cables, motors, and other electrical equipment.
- B. Functional testing of all electrical systems shall be performed. Prior to functional testing, all protective devices shall be adjusted and made operative. Prior to energizing the equipment, the Contractor shall perform a functional checkout of each individual control circuit. Checkout shall consist of energizing each control circuit and operating each control device and verifying that the specified action occurs. The Contractor shall submit a description of the proposed functional test procedures prior to the performance of the functional checkout.

3.05 TRAINING

- A. After substantial completion of the work, O&M manuals have been delivered to the owner, all testing is complete and final inspection of the work by the Authority(s) Having Jurisdiction, the Contractor shall demonstrate the electrical systems and instruct the Owner's designated operation and maintenance personnel in the operations and maintenance of the various electrical systems. The Contractor shall arrange scheduled instruction periods with the Owner. The Contractor's representatives shall be knowledgeable in each system and suppliers representatives, when so specified.
- B. Scheduled minimum instruction period at each location shall be:
 - 1. Electrical Systems 8 Hours
 - 2. Control Systems 24 Hours

3.06 FINAL ACCEPTANCE

- A. Prior to final acceptance, the Engineer will perform one or more site observation trips to develop a punch list of items deemed incomplete. The Electrical Contractor shall be present while these inspections are taking place and shall be available for opening cabinets and operating and adjusting the system as is necessary for the Engineer to verify all equipment is installed and operates to the requirements of the contract documents.
- B. The Contractor shall complete all items of work, including wire markers, nameplates, final tests and final test reports prior to requesting final acceptance inspections. All equipment shall be checked for proper operation and all signals verified for correct calibration and

wiring. Fixtures shall have been cleaned, and burned out or defective lamps shall have been replaced.

3.07 STANDARD ABBREVIATIONS

Abbreviation	Definition
Accepted	Reviewed with no exceptions taken to submittal material.
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
Approved	Inspected and accepted by the Authority Having Jurisdiction
ASTM	American Society for Testing Materials
Boxes	Outlet, Junction or Pull Boxes
Code	All codes currently enforced at project location
Compression	Compressed using a leverage powered crimping tool
Connection	All materials and labor required for equipment to be fully operational
CSI	Construction Specifications Institute
EMT	Electrical Metallic Tubing
Exterior	Outside of outer surfaces of the location building
Fully Operational	Tested and approved and operating to the satisfaction of the AHJ, manufacturer and contract documents
Furnish	Purchase and deliver material
Install	Install and make fully operational
kcmil	Thousand circular mils (also MCM)
Mfr	Manufacturer
NEC	National Electric Code NFPA #70 current revision as adopted by AHJ
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Noted	Shown or specified in the contract documents
PVC	Polyvinyl Chloride
Provide	Furnish and install
RGS, GRS	Rigid Galvanized Steel
Required	As required by code, AHJ, or contract documents for the installation to be fully operational
Shop Drawing	Hand drafted document which fully details the equipment and intended installation relative to this specified project
Shown	As indicated on the drawings or details
Submittal	Material for Engineer review which may include catalog cuts, shop drawings, wiring diagrams, etc., of the actual material being furnished.
UL	Underwriters Laboratories, Inc.
Wiring	Raceway, conductors and connections

*** END OF SECTION ***

SECTION 26 05 19 – WIRE AND CABLE

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies conductors and cables rated to 600 volts used for power, lighting, receptacle, signal, and control circuits.

PART 2 PRODUCTS

2.01 GENERAL

- A. With the exception of lighting, communication, paging, security and receptacle circuits, the type, size and number of conductors shall be as specified on the drawings or schedules. Lighting and receptacle circuit conductors are unscheduled and shall be sized by the Contractor in accordance with the NEC to limit voltage drop to 3 percent. Number and types of communication, paging, and security cables shall be a required for the particular equipment provided.

2.02 LIGHTING AND RECEPTACLE BRANCH CIRCUIT CONDUCTORS

- A. Lighting and receptacle conductors shall be stranded except for 12 AWG which shall be solid. Minimum conductor size shall be 12 AWG.
- B. Conductors shall be provided with the following characteristics:
 - 1. Voltage: 600 volts
 - 2. Conductor: Bare soft annealed copper, Class B stranded per ASTM-8; solid per ASTM B-3
 - 3. Insulation: THWN/THHN, 90 degree C dry, 75 degree C wet polyvinylchloride (PVC)
 - 4. Jacket: Nylon
 - 5. Flame resistance: UL 83
 - 6. Manufacturer: Okonite; Southwire; or equal

2.03 POWER AND CONTROL CONDUCTORS AND CABLE, 600 VOLT

- A. Single Conductor:
 - 1. Single conductor cable shall be stranded and shall be used in conduits for power and control circuits.
 - 2. Conductor shall be provided with the following characteristics:

- a. Voltage 600 volts
- b. Conductor: Uncoated, soft annealed copper, Class B stranded per ASTM B-8
- c. Insulation: Power #6 AWG and larger: XHHW-2, 90 degrees C cont. rating, wet or dry.
- d. Power up to #6 AWG: THHN/THWN, 90 degrees C cont. rating, wet or dry
- e. Control: THHN/THWN, 90 degrees C cont. rating, wet or dry
- f. Flame resistance: UL 83
- g. Manufacturer: Okonite, Southwire; Anaconda; or equal

2.04 CONNECTORS

- A. Pre-insulated Connectors for splices and taps in conductors 10 AWG and smaller shall be Ideal Industries "Wing Nut" or 3M Company "SCOTCHLOCK", or equal. For 8 AWG and larger conductors shall be T&B compression connectors, or equal. Compress using manufacturers recommended die and tools.
- B. Waterproof silicone filled "wing nut" type connectors or spade/lug type terminations and terminals and coat with liquid insulation shall be used for all connections of wire to cord to removable equipment provided with integral cords (such as floats, transmitters, limit switches, etc.) in junction boxes in underground hand holes or outdoor junction boxes. Insulators shall be Thomas and Betts multi splice insulator MSLT112-4, or equal.

2.05 SPLICE INSULATION

- A. Splice insulation shall be equal or greater than the insulation level of the conductor used.
- B. All permanent splices that are underground or in damp or corrosive environments shall be insulated with cast epoxy type insulation which covers the jacket of all cords and the insulation on all wire. Epoxy splice shall be Scotch #3570 or equal.

2.06 WIRING SCHEDULE

- A. Refer to cable schedule for description of conductors required.

2.07 MOTOR TERMINAL SPLICE INSULATION

- A. Motor terminal splice insulation in the motor connection box shall be provided which will withstand constant vibration and abrasion without degrading the insulation of the splice. A product shall be used that is specifically designed for the purpose of motor terminations in accordance with the following:
 - 1. Motor splices in general purpose areas: bolted splice with a TY-RAP boot type insulator, Thomas and Betts Splice insulator Series MSC, or equal. Splices using

wire larger than 8 AWG may be heat shrinkable motor connection stub splices, Raychem, MCK-V series, or equal.

2. Motors in outdoor, damp, or corrosive environments: waterproof motor stub insulator, Thomas and Betts multi splice insulator MSLT112-4, or equal. Splices using wire larger than 8 AWG may be heat shrinkable motor connection stub splices, Raychem, MCK-V series, or equal.

2.08 WIRE MARKERS

- A. Field installed wire markers shall be T&B SMS pre-printed clip-on markers, or equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Each power and control conductor shall be identified at each terminal to which it is connected.
- B. Pulling wire and cable into conduit or trays shall be completed without damaging or putting undue stress on the cable insulation. Soapstone, talc or UL listed pulling compounds are acceptable lubricants for pulling wire and cable. Grease is not acceptable. Raceway construction shall be complete, cleaned, and protected from the weather before cable is placed in the raceway.

3.02 600 VOLT CONDUCTOR AND CABLE

- A. Conductors in panels and electrical equipment, 6 AWG and smaller, shall be bundled and laced at intervals not greater than 6 inches, spread into trees and connected to their respective terminals. Lacing shall be made up with plastic cable ties. Lacing is not necessary in plastic panel wiring duct. Conductors crossing hinges shall be bundled into groups not exceeding 12 and shall be so arranged that they will be protected from chafing when the hinged member is moved.
- B. Slack shall be provided in junction and pull boxes and hand holes. Slack shall be sufficient to allow cables or conductors to be routed along the walls of the box. Amount of slack shall be equal to largest dimension of the box. Where plastic panel wiring duct is provided for wire runs, lacing is not required.
- C. Solid wire shall not be lugged, nor shall electrical spring connectors be used on any except for solid wires in lighting and receptacle circuits. Lugs and connectors shall be installed with a compression tool.
- D. All splices and terminations are subject to inspection by the Engineer prior to and after insulating. Terminations at 460-volt motors shall be made by bolt-connecting the lugged connectors. Connections shall be insulated and sealed with factory-engineered kits. Bolt connection area shall be kept free of mastics and fillers to facilitate rapid stripping and re-entry. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

- E. In-line splices and tees, where approved, shall be made with tubular compression connectors and insulated as specified for motor terminations, except that conductors 10 AWG and smaller may be spliced using self-insulating connectors. Splices and tees in underground handholes or pull boxes shall be insulated using Scotch-cast epoxy resin splicing kits. Terminations at devices with 120 volt pigtail leads shall be made using self-insulating tubular compression connectors.
- F. Terminations at solenoid valves, 120 volt motors, and other devices furnished with pigtail leads shall be made using self insulating tubular compression connectors.
- G. In the case where multiple field located instrumentation and control devices require parallel or series wiring configuration, it shall be done at one location in one junction box with terminals. Interconnection of instrumentation and control devices shall not be done within conduit bodies (i.e. LBs, condulets, etc.)
- H. Provide shielded power cable for leads extending from VFDs to motors, where indicated.

3.03 SIGNAL CABLING

- A. Circuit runs shall be of individually shielded twisted pairs or triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever 3-wire circuits are required. Terminal blocks shall be provided at instrument cable junctions unless otherwise specified. Signal circuits shall be run without splices between instruments, terminal boxes, or panels.
- B. Shields shall not be used as a signal path, except for coaxial cable circuits operating at radio frequencies.
- C. Unless otherwise specified, shields shall be bonded to the signal ground bus at the control panel and isolated from ground and other shields at other locations. Terminals shall be provided for running signal leads and shield drain wires through junction boxes.
- D. Spare circuits shall be terminated on terminal blocks at both ends of the cable run and be electrically continuous through terminal boxes. Shield drain wires for spare circuits shall not be grounded at either end of the cable run. Terminal boxes shall be provided at instrument cable splices. If cable is buried or in raceway below grade at splice, an instrument stand shall be provided as specified with terminal box mounted approximately 3 feet above grade.
- E. Cable for paging, telephone, and security systems shall be installed and terminated in compliance with the manufacturer's recommendations.

3.04 COLOR CODING

- A. Wiring shall conform to the following color code, unless otherwise specified.
- B. Insulation on phase conductor sizes 8 AWG and smaller shall be colored, 6 AWG and larger may have black insulation with plastic tape of the appropriate color from the table below.

- C. Insulation on the grounded conductor (neutral) sizes 6 AWG and smaller shall be colored; 4 AWG and larger may have black insulation with plastic tape of white or gray in accordance with the table below.

Description	208Y/120V	480Y/277V	Control
Phase A (Left, Top, Front)	Black	Brown	--
Phase B (Center, Center, Center)	Red	Orange	--
Phase C (Right, bottom, Back)	Blue	Yellow	--
Neutral	White	Gray	White
Ground	Green	Green	Green
120 VAC Control	--	--	Red
120 VAC Control	Neutral	--	White
DC Control (+)	--	--	Blue
DC Control (-)	--	--	Blue/Wht Stripe
External Source	--	--	Yellow

- D. All control wiring in control panels or other enclosures that is powered from an external source and is not disconnected by the control panel disconnect shall be terminated at a disconnecting terminal block upon entering the enclosure. The color of the wire shall then be changed to yellow to identify it as being powered from an external source. Provide identification nameplate on exterior of enclosure to indicate sources of external power.

3.05 TERMINAL MARKING

- A. All terminals in instrument and relay compartments, motor control centers, in control panels, instrument panels, field panels and control stations, as well as connections to mechanical equipment shall have reference number and letter.

3.06 WIRE BENDING RADIUS

- A. The radius of bends in all non-shielded wire (conductors and cables) shall not be less than eight (8) times the outside diameter of the wire. Shielded or lead covered wire shall not be bent to a radius less than twelve (12) times the diameter of the wire. Any wire installed with bends less than the allowed diameter and which the Engineer deems has caused that insulation to be damaged, shall be removed and new wire shall be installed.

3.07 GENERAL TESTS

- A. The Contractor shall perform voltage, current and resistance tests as required in this section. Test reports shall be submitted to the Engineer prior to final acceptance by the Owner. The Contractor shall inform the Engineer of scheduled testing a minimum of 5 days prior to the testing.

- B. The Contractor shall undertake all such corrective measures if the test results indicate corrective measures are required. No additional compensation will be paid for corrective measures
- C. Test Scope
 - 1. The Contractor shall provide all material, equipment, labor and technical supervision to perform tests and inspections as specified herein.
 - 2. It is the intent of these tests to assure that all electrical equipment as supplied and installed by the Contractor is operational within the industry and manufacturer's tolerances and is installed in accordance with the design documents.
 - 3. The tests and inspection shall determine the suitability for energization.
- D. Conductor Tests
 - 1. Following the completion of installation, the following conductors shall be tested:
 - a. All power feeders scheduled in Conduit and Cable Schedule.
 - b. Service conductors and feeder conductors
 - c. All new grounding; measure ground resistance at each ground rod.
- E. Visual and Mechanical Inspections
 - 1. Inspect exposed section for physical damage.
 - 2. Verify cable is supplied and connected in accordance with specifications and one line diagram, and that phases are labeled correctly.
- F. Electrical Tests
 - 1. Perform insulation resistance test on each cable in reference to ground and adjacent conductors in the same raceway.
 - 2. Perform continuity test to ensure proper cable connection.
 - 3. Perform thermal imaging inspection on all power terminations.
- G. Test Values
 - 1. Insulation resistance tests shall be performed at 1000 volts DC for one-half minute.
 - 2. Minimum megger readings at 20 degrees C shall be one megohm.

3. The maximum acceptable reading for an individual ground rod shall be 25 ohms as required by the NEC and measured by the three rod method. The composite ground electrode shall have a maximum acceptable reading of 15 ohms.

*** END OF SECTION ***

SECTION 26 05 26 – GROUNDING AND BONDING

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. This specification describes the requirements for the grounding of electrical systems and equipment.
- B. Installation shall be in accordance with the National Electrical Code (NEC).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Ground wire: Soft drawn bare stranded copper wire, sized as noted on the drawings.
- B. Terminals and connectors: Burndy Hyground compression system.
- C. Exothermic type weld: Erico Cadweld process, or Fuseweld/T&B corp. Exothermic welding system.
- D. Rod Electrodes: Copper clad (minimum 0.010 jacket) ground rods minimum ¾” diameter x 8’ long.
- E. Grounding Electrode conductors and bonding conductors: Copper conductors, bare or insulated, as shown on drawings.

PART 3 EXECUTION

3.01 PREPARATION

- A. All contacting surfaces of ground connections shall be cleaned to bright metal before connection is made.

3.02 INSTALLATION

- A. Grounding conductors: Install in PVC conduit where subject to damage. All grounding conductors smaller than #6 AWG must be protected.
- B. Connections and splices: Provide as required and as shown on drawings.
- C. Connections, taps, and splices shall be made by compression connectors, Burndy Hyground compression system.
- D. Provide equipment grounding conductor in all PVC conduits.

*** END OF SECTION ***

SECTION 26 05 33 – RACEWAYS AND BOXES

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies raceways for electrical conductors including fittings and supports. Raceways shall be provided for power, control, instrumentation, grounding, lighting, receptacles, and signaling systems. Raceways consist of conduits, tubing, and tray systems. For the purpose of this specification, conduit and tubing is described collectively as conduit.

PART 2 PRODUCTS

2.01 GENERAL

- A. Material
 - 1. All materials shall be new, free from defects, of current manufacture, of quality specified or shown. Each type of material shall be of the same manufacturer throughout the work.
- B. Unscheduled Raceway
 - 1. With the exception of lighting, communication, paging, security and receptacle circuits, the type and size of raceway shall be as specified on the drawings or schedules. Lighting and receptacle raceway are unscheduled and shall be sized by the contractor in accordance with the NEC. Minimum size shall be 1/2 inch for exposed and 1 inch for embedded raceway.
- C. Scheduled Raceway
 - 1. The size and type of raceway shall be as specified on the drawings or schedules. In case of conflicts between the drawings and paragraph 3.1, the drawings shall prevail.

2.02 RACEWAY

- A. Application – also see Area Classifications Section 26 05 00.1.10.
 - 1. All conduits shall be Galvanized Rigid Steel (GRS), unless otherwise noted.
 - 2. All connections to vibrating equipment or motors shall be liquid-tight flexible metallic conduit.
 - 3. PVC installed above grade shall be UV resistant Schedule 80.
 - 4. Underground power, control and telephone conduits shall be schedule 40 PVC. (All sweeps and risers for transition from below grade to above grade shall be PVC coated, GRS), unless indicated otherwise.

5. Underground conduits serving non-critical loads such as site lighting, signs, etc. shall be PVC schedule 40.
 6. Indoor lighting and receptacle circuits may be EMT. Conduit shall be concealed where possible.
- B. Rigid Steel Conduit (RGS)
1. Rigid conduit shall be steel, hot dipped galvanized. Final conduit terminations shall be by means of threaded hubs or double locknuts and insulating grounding type bushings.
- C. Liquid Tight Flexible Metallic Conduit
1. Flexible conduit shall be interlocking single strip, hot dipped galvanized and shall have a polyvinyl chloride jacket extruded over the outside to form a flexible watertight raceway.
- D. Nonmetallic Conduit
1. Nonmetallic conduit shall be rigid PVC, Schedule 40 or 80. Fittings shall be of the same material as the raceway and installed with solvent cement per the manufacturer's instructions. Conduit, fittings and solvent cement shall all be manufactured by the same manufacturer.
- E. PVC Coated Rigid Steel Conduit
1. Conduit shall be hot dip galvanized, then coated with urethane inside and outside, then covered with 40 mil PVC coating.
- F. Aluminum Conduit
1. Aluminum conduit shall be rigid ANSI C80.5, threaded.
- G. Electrical Metallic Tubing (EMT)
1. EMT shall be UL 797 and ANSI C80.3, steel tubing, hot-dip galvanized. EMT fittings shall be ANSI/NEMA FB 1, steel, rain-tight, insulated throat, compression type.

2.03 FITTINGS AND BOXES

- A. Material
1. Materials for fittings and boxes shall be chosen to satisfy the requirements of Paragraph 26 05 00.1.10 - Area Classification. All screws, nuts, bolts, and other hardware used with fittings and boxes shall be stainless steel unless installed in general purpose areas.
- B. Unions

1. All unions of the type designated as UNF and UNY and shall be suitable for use in moist atmospheres. Unions shall be of cast ferrous alloy, electroplated with zinc.

C. Locknuts

1. All locknuts used in general purpose areas shall be extra heavy steel electroplated with zinc for sizes $\frac{3}{4}$ inch to 2 inches. Locknuts larger than 2 inches shall be of malleable iron, electroplated with zinc. Locknuts used in damp and outdoor areas shall be stainless steel. Locknuts in corrosive areas shall be FRP.

D. Bushings

1. All bushings shall be steel or malleable iron threaded type electroplated with zinc or hot-dip galvanized. Bushings shall have a molded-phenolic or nylon insulating collar.
 - a. Grounding Bushings: Grounding-type bushings shall have a projecting portion drilled for the size grounding cable used and shall be provided with a clamp or set screw for securing the cable. In addition, a set screw shall be provided to securely lock the bushing to the conduit. Grounding bushings shall be GEDNEY Type IBC-L-BC, or T&B No. 3870 through 3880, or T&B BG Series, or equal.
 - b. Bushed Openings: Bushings for protection of cables passing through metal boxes or troughs shall all be phenolic type and shall be OZ Type ABB, or equal.
 - c. Hubs for connection of conduit to boxes shall be of zinc. Hubs for use in damp or corrosive areas shall be non metallic or aluminum to match the raceway. The hubs shall provide a liquidtight connection to the box and an insulating bushing for the wiring. Hubs shall be Thomas and Betts bullet type, or equal.

E. Liquidtight Flexible Metallic Conduit Connectors:

1. Connectors for liquidtight flexible metallic conduit shall be electroplated zinc malleable iron. An O-ring gasket and an approved grounding insert shall be part of the unit. Where applicable, 45 degree and 90 degree fittings may be used. Liquid-tight connectors shall be by O.Z. GEDNEY, or equal.

F. Expansion Fittings

1. Expansion fittings in exposed runs shall be weatherproof type and shall be provided with an external bonding jumper. The expansion fittings shall allow for 4 inch longitudinal movement and shall be designed so that when completely assembled the end of each conduit entering the fitting is bushed. Fittings shall be O.Z. GEDNEY Type EX, or equal.
2. Deflection fittings in embedded runs shall be of the watertight type and shall be provided with an internal bonding jumper. The expansion material shall be neoprene and shall allow for $\frac{3}{4}$ inch movement in any direction. Fittings shall be O.Z. GEDNEY Type DX, or equal.

G. Junction Boxes

1. Junction boxes, device boxes, fixture support boxes, oblong, round and rectangular conduit fittings (condulets) shall be of the same material as required by the area classification for the raceway. Junction boxes for use in general purpose areas shall be zinc electroplated cast ferrous alloy. Integrally cast threaded hubs or bosses shall be provided for all conduit entrances and shall provide for full 5 thread contact on tightening. Drilling and threading shall be complete before finishing. Boxes shall be Crouse-Hinds type FS, FD, or approved equal.
2. Cover plates shall be of similar cast ferrous alloy material and finish. Full body neoprene gaskets shall be provided with all covers and shall fastened with stainless steel screws.
3. NEMA 12 boxes shall be of heavy gauge sheet steel, or cast metal. All NEMA 12 boxes shall be provided with a 5 mil thick light gray thermo-epoxy finish, and designed so that moisture will drain away from the gasketed cover joint. Covers for sheet steel boxes shall have turned edges, ground smooth to form a tight seal against the gasket when the cover is closed.

2.04 CONDUIT & CABLE SUPPORTS

A. Conduit Supports

1. Hot-dip galvanized framing channel shall be used to support groups of conduit. Individual conduit supports shall be one-hole galvanized malleable iron pipe straps used with galvanized clamp backs and nesting backs where required. Conduit supports for PVC or epoxy coated rigid steel and PVC conduit systems shall be one hole PVC or epoxy coated clamps or PVC conduit wall hangers.

B. Ceiling Hangers

1. Ceiling hangers shall be adjustable galvanized carbon steel rod hangers as specified. Straps or hangers of plumber's perforated tape are not acceptable. Unless otherwise specified, hanger rods shall be 1/2-inch all-thread rod and shall meet ASTM A193. Hanger rods in corrosive areas and those exposed to weather or moisture shall be stainless steel.

C. Racks

1. Racks shall be constructed from framing channel. Galvanized channels and hanger rods shall be steel, hot dip galvanized, 1.5 oz. / sq. ft. after fabrication. Field cuts shall be re-galvanized by the Galv-A-Weld process or equal. Channels attached directly to building surfaces shall be 14 gauge minimum thickness, 1-5/8 inch deep.
2. Framing channels on all exterior areas and in corrosive areas shall be aluminum stainless steel, or fiberglass. All hardware shall be stainless steel. Framing channel shall be as manufactured by Unistrut or equal.

2.05 CONDUIT SCHEDULE

- A. Refer to conduit schedule on the drawings for raceway sizing and routing description.
- B. Conduit sizing and conductor quantities shall be adjusted as necessary for minor changes based on equipment submittals, at no additional cost to the Owner.

2.06 CONDUIT TAGS

- A. Conduit tags shall be corrosion resistant and remain legible after exposure to abrasion or aggressive fluids. Tags shall be crosslinked polyolefin construction. Manufacturer shall be Impact Industries, or equal.

2.07 HAND HOLES

- A. Hand holes shall be precast concrete with checker plate, galvanized, traffic covers designed for H-20 loading. Dimensions shall be as specified on the drawings. Hand holes shall be provided with precast solid concrete slab bottoms with sumps, with drains, or as shown on the drawings. Hand holes shall be construction of 3000 psi reinforced concrete.

2.08 UNDERGROUND MARKING TAPE (DETECTABLE TYPE)

- A. Underground marking tape shall be for location and early warning protection of buried power and communication lines. Tape shall be detectable by a pipe / cable locator or metal detector from above the undisturbed ground. Tape shall be nominally 2 inches wide with a type B721 aluminum foil core laminated between two layers of 5 mil thickness polyester plastic. The plastic color shall be red for electrical lines and orange for telephone lines. A warning shall be imprinted continuously along the length, with message reading similar to: "CAUTION - STOP DIGGING - BURIED ELECTRIC (TELEPHONE) LINE BELOW." Tape shall be Brady "Detectable Identoline"; Services and Materials "Buried Underground Tape, Detectable", or equal.

PART 3 EXECUTION

3.01 CONDUIT

A. General

1. The Contractor shall limit the number of directional changes of the conduit to a total not more than 270 degrees in any run between pull boxes. Conduit runs shall be limited to 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction. Bends and offsets shall be avoided where possible but, where necessary, shall be made without flattening or kinking, or shall be factory preformed bends. Turns shall be made with case metal fittings or conduit bends. Welding, brazing or otherwise heating of conduit is not acceptable.
2. Where required for pulling cable and as necessary to meet the requirements of the previous Paragraph, the Contractor shall provide cast junction or pull boxes.

3. Conduit entering NEMA 1 type sheet steel boxes or cabinets shall be secured by locknuts on both the interior and exterior of the box or cabinet and shall have an insulating grounding or bonding bushing constructed over the conduit end. Conduit entering all other boxes shall be terminated with a threaded hub. Cast boxes and nonmetallic enclosures shall have threaded hubs. Joints shall be made with standard couplings or threaded unions. Metal parts of nonmetallic boxes and plastic coated boxes shall be bonded to the conduit system. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. The ends of conduit shall be cut square, reamed and threaded with straight threads.
4. Unless otherwise specified, conduit entering field equipment enclosures shall enter the bottom or side of the box. Where conduit comes from above, it shall be run down beside the enclosure and a tee conduit and drip leg shall be installed.
5. When new conduit is added to areas which are already painted, the conduit and its supports shall be painted to match the existing facilities. Where new conduit is used to replace existing conduit, the existing conduit and supports shall be removed, resulting blemishes shall be patched and repainted to match original conditions.

B. Conduit Support

1. Exposed conduit shall be run on supports spaced not more than 10 feet apart and shall be constructed with runs parallel or perpendicular to walls, structural members, or intersections of vertical planes and ceiling.
2. Where three or more conduits are located in a parallel run, they shall be spaced from the wall using framing channel. Support systems shall be galvanized steel unless otherwise specified.
3. Conduit rack and tray supports shall be secured to concrete walls and ceilings by means of cast-in-place anchors. Individual conduit supports shall use cast-in-place anchors, die-cast, rust-proof alloy or expansion shields. Wooden plugs or plastic inserts are not acceptable as a base to secure conduit supports.

C. Conduit Penetrations

1. Unless otherwise specified, conduit routed perpendicular through floors, walls or other concrete structures shall pass through cast-in-place openings wherever possible. In cases where cast-in-place openings are not possible, appropriate size holes shall be bored through the concrete to accommodate the conduit passage. The size and location of the holes shall not impair the structure's integrity. After completion, grout or caulk around conduit and finish to match existing surroundings. Unless otherwise protected, conduits that rise vertically through the floor shall be protected by a 3 1/2-inch high concrete pad with a sloping top.
2. Conduits entering manholes and handholes shall be horizontal. Conduits shall not enter through the concrete bottom of handholes and manholes.

3. Wherever conduits penetrate outdoor concrete walls or ceilings below grade, the Contractor shall provide a watertight seal as manufactured by O.Z. Gedney Co., Type CSM Series; Thunderline Corp., Link Seal; or equal.
4. Wherever conduits enter buildings or structures below grade, seal the conduit opening (after installation of conductors and cables), with conduit sealing material, to prevent water from entering the structure, enclosure, etc. Sealing compound to be a pliable, removable putty-type compound listed for the application.

D. Conduit Separation

1. Signal conduits shall be separated from AC power or control conduits. The separation shall be a minimum of 12 inches.

E. Conduit Seals for Hazardous or Corrosive Areas

1. Each conduit passing from a hazardous or corrosive area into a non-hazardous or non-corrosive area shall be provided with a sealing fitting which may be located on either side of the boundary. The seal shall be located at the boundary in accordance with NEC article 500.
2. Seal fittings for conduit systems in hazardous atmosphere locations shall be hot-dip galvanized case ferrous alloy. Sealing compound shall be hard type, Chico A, or equal, UL listed for explosion-proof sealing fittings. Sealing compound shall be non-hardening type for corrosive areas. Provide reducing bushings and larger seals as required to meet NEC 25% fill.

3.02 HAND HOLES

1. Hand holes shall be set plumb and the tops shall be at finished grade level, or as shown on the drawings.
2. Drainage systems shall be installed to prevent the buildup of standing water inside the hand hole.

*** END OF SECTION ***

SECTION 26 22 13 – DRY TYPE TRANSFORMERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies dry-type transformers rated 600 volts and less used for power distribution, lighting and control purposes.

1.02 MATERIALS

- A. All materials shall be new, free from defects, of current manufacture, of quality specified or shown. Each type of material shall be of the same Manufacturer throughout the work.

1.03 STANDARDS AND CODES

- A. All materials and equipment specified herein shall be within the scope of Nationally Recognized Testing Laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

1.04 EQUIPMENT SIZE

- A. Electrical equipment shall fit in the space provided on the plan drawings or as specified. Equipment heights shall not exceed those shown or specified. Larger equipment shall not be considered equivalent or acceptable.

1.05 SUBMITTALS

- A. Submit all catalog data in accordance with the Submittals requirements in Section 26 05 00. Show material information and confirm compliance with these specifications.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Reference drawings for transformer size and windings. Transformers shall conform to ANSI/IEEE C57.12.01 and ANSI/ UL 506. The voltage, frequency, number of phases and KVA rating shall be as specified. Transformers shall be General Electric, Square D, Westinghouse, or equal.

2.02 INSULATION

- A. Transformers 15 KVA and above shall have a Class 220 insulation system in accordance with NEMA ST20. Transformers 2 KVA and less shall be designed not to exceed 80 degrees C temperature rise. Transformers 3 KVA and greater shall be designed not to exceed 115 degree C temperature rise.

2.03 COILS

- A. Transformer coils shall be copper. Transformer coils 15 KVA and above shall be

impregnated with varnish. Transformer coils 10 KVA and below shall be encapsulated.

2.04 WINDING CONFIGURATION

- A. Transformers shall have electrically isolated primary and secondary windings. Primary and secondary winding configurations shall be as specified. Provisions shall be made to permit separate grounding of the neutral conductor and enclosure. Single-phase transformers shall be the four winding type.

2.05 TRANSFORMER TAPS

- A. Transformers 15 KVA and above shall be provided with two 2-1/2 percent full capacity taps above normal voltage and four 2-1/2 percent full capacity taps below rated voltage on the primary winding.

2.06 TERMINAL COMPARTMENTS

- A. Terminal compartments shall be sized to permit termination of cables specified. Terminal connections shall be made in the bottom third of the enclosure. The terminals shall be copper and sized for cable specified.

2.07 ENCLOSURES

- A. Transformers rated 15 KVA and smaller shall be provided with weatherproof, non-ventilated enclosures.
- B. Indoor transformers rated greater than 15 KVA shall be provided with drip proof, ventilated enclosures. Outdoor transformers shall have weatherproof enclosures.

2.08 MOUNTING

- A. Transformers 15 KVA and below shall be suitable for wall mounting.
- B. Transformers 20 KVA and larger shall be floor mounting type.

2.09 SOUND LEVELS

- A. The sound levels shall not exceed the following values:

<u>KVA</u>	<u>dB</u>
0-9	40
10-45	42
50-150	45
225-300	50
500	54

2.010 TRANSFORMER EFFICIENCY

- A. Transformers shall be energy-efficient and shall meet the following minimum ratings:

Single Phase		Three Phase	
kVA	Efficiency (%)	kVA	Efficiency (%)
15	97.7	15	97.0
25	98.0	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98.0
75	98.5		

PART 3 EXECUTION

3.01 INSTALLATION

- A. Transformers shall include internal "rubber-in-shear" isolation mounts selected per Manufacturer's recommendations or shall be installed with "KORFUND" or equal external vibration isolators. Wall mounting shall be allowed on masonry. Mounting hardware shall be per Manufacturer's instructions. Transformers with enclosures designed for floor mounting where suspended from above shall be suspended on a trapeze constructed of a minimum of two horizontal structural channels hung from threaded rod attached to structural slab with inserts. Channel rod and inserts shall be sized for not less than 400% load safety factor. Transformer raceway connections shall be flexible metal conduit as specified hereinbefore for equipment subject to vibration.

3.02 CONNECTION

- A. Transformers shall be considered "grounded neutral separately derived systems" and neutral shall be grounded accordingly to the building ground grid utilizing a direct connection.

3.03 IDENTIFICATION

- A. The transformer shall be identified with engraved, phenolic nameplates.

*** END OF SECTION ***

SECTION 26 24 16 – PANELBOARDS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies panelboards for lighting and power distribution.

1.02 SUBMITTALS

- A. Submit all catalog data in accordance with the Submittals requirements in Section 26 05 00. Show material information and confirm compliance with these specifications.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Panelboards shall be manufactured by Square D, Cutler Hammer, or equal.

2.02 MATERIALS - LIGHTING AND APPLIANCE PANELBOARD

A. Interior

1. Continuous main current ratings, as indicated on associated panel schedules or drawings, not to exceed 600 amperes maximum for main breaker panelboards and not to exceed 800 amperes for main lug panelboards.
2. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors limited to bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100-400 amperes shall be plated copper. Bussing rated for 600 and 800 amperes shall be plated copper as standard construction. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and -G.
3. All current-carrying parts shall be insulated from ground and phase-to-phase by high dielectric strength thermoplastic.
4. A solidly bonded copper equipment ground bar shall be provided. An additional copper isolated/insulated ground bar shall also be provided.
5. Split solid neutral shall be plated and located in the mains compartment up to 250 amperes so all incoming neutral cable may be of the same length. UL Listed panelboards with 200% rated solid neutral shall be plated copper for non-linear load applications. Panelboards shall be marked for non-linear load applications.
6. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.
7. Nameplates shall contain system information and catalog number or factory order number. Interior wiring diagram, neutral wiring diagram, UL Listed label and

short circuit current rating shall be displayed on the interior or in a booklet format.

8. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 125A interiors shall be vertically mounted. Main circuit breakers over 125A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.
9. Interior phase bus shall be pre-drilled to accommodate field installable options. (i.e., Sub-Feed Lugs, Sub-Feed Breakers, Thru-Feed Lugs)
10. Interiors shall accept 125 ampere breakers in group mounted branch construction.

B. Main Circuit Breaker

1. Main circuit breakers shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40° C ambient environment. Thermal elements shall be ambient compensating above 40° C.
2. Two- and three-pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.
3. Circuit breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL Listed for reverse connection without restrictive line or load markings.
4. Circuit breaker escutcheon shall have international I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON or OFF position.
5. Lugs shall be UL Listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 90° C rated wire, sized according to the temperature rating per NEC Table 310-16. Lug body shall be bolted in place; snap-in designs are not acceptable.
6. The circuit breakers shall be UL Listed for use with the following accessories: Shunt Trip, Under Voltage Trip, Ground Fault Shunt Trip, Auxiliary Switch, Alarm Switch, Mechanical Lug Kits, and Compression Lug Kits.

C. Branch Circuit Breakers

1. Circuit breakers shall be UL Listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panelboard schedule.
2. Molded case branch circuit breakers shall have bolt-on type bus connectors.
3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two- and three-pole circuit breakers shall

have common tripping of all poles.

4. There shall be two forms of visible trip indication. The circuit breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red indicator appearing in the clear window of the circuit breaker housing.
5. The exposed faceplates of all branch circuit breakers shall be flush with one another.
6. Lugs shall be UL Listed to accept solid or stranded copper conductors only.
7. Breakers shall be UL Listed for use with the following factory installed accessories: Shunt Trip, Auxiliary Switch, and Alarm Switch.

D. Enclosures

1. Type 1 Boxes
 - a. Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
 - b. Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.
 - c. Box width shall not exceed 26" wide.

E. Type 1 Fronts

1. Front shall meet strength and rigidity requirements per UL 50 standards. Shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
2. Fronts shall be 1-piece with door, or hinged 1-piece with door. Mounting shall be as indicated on associated schedules and drawings.
3. Panelboards rated 250 amperes and below shall have MONO-FLAT fronts with concealed door hinges and trim screws. Front shall not be removable with the door locked. Panelboards rated above 250 amperes shall have vented fronts with concealed door hinges. Doors on front shall have rounded corners; edges shall be free of burrs.
4. Front shall have flat latch type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

F. Type 3R, 5, and 12

1. Enclosures shall be constructed in accordance with UL 50 requirements. Enclosures shall be painted with ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.
2. All doors shall be gasketed and equipped with a tumbler type vault lock and two (2) additional quarter turn fasteners on enclosures 59 inches or more in height. All lock assemblies shall be keyed alike. One (1) key shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.
3. Maximum enclosure dimensions shall not exceed 21" wide and 9.5" deep.

G. Circuit Breaker ratings

1. The following interrupting capacity shall be considered minimum. Other ratings shall be as specified on the drawings.
 - a. 240V and 208Y/120V Panelboards 10,000 AIC symmetrical
 - b. 480V and 480Y/ 277V Panelboards 25,000 AIC symmetrical
2. Breakers shall be mounted in panelboards so that breaker handles operate in a horizontal plane. Common trip shall be provided on all multiple pole breakers. Circuit breaker shall be the bolt-on type.
3. Spare breakers shall be provided where indicated, complete for future connection of wiring circuits. Where "Space" is indicated for breakers, bussing and breaker mounting hardware shall be provided in the panelboards; with steel knockouts in dead front metal closure of unused part of panel. If any steel knockouts are removed, breakers shall be provided in such spaces or approved cover plates. Open spaces are not permitted.

H. Surge Arresters

1. Surge arresters, with indicators, shall be provided on all panels to protect against overvoltage transients.

I. Panel schedules

1. Panel Schedules are shown on the drawings.

PART 3 EXECUTION

3.01 MOUNTING

- A. Secure in place with top of cabinet at 6' – 6", unless otherwise noted. Top of cabinet and trim shall be level.

3.02 CIRCUIT INDEX

- A. Each branch circuit panelboard shall be provided with as built information for each panelboard by circuit with its proper load designation. Panelboard index card shall be typed (handwritten not acceptable) and mounted inside the door of each panelboard in a clear plastic sleeve. One spare blank card shall be provided for each card used.

3.03 FIELD QUALITY CONTROL

- A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

- C. Check tightness of bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

*** END OF SECTION ***

SECTION 26 24 19 – MOTOR CONTROL CENTERS

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies free standing, factory assembled Low Voltage (600 volt) Motor Control Centers (MCC).

1.02 COORDINATION

- A. The Contractor shall be responsible for furnishing the motor control center including all related equipment as shown on the drawings and as specified herein. The Electrical Contractor shall be responsible for installing the motor control center, interconnecting wiring and all related equipment.
- B. The Contractor shall coordinate equipment information with the MCC manufacturer so that the correct type of motor starters and protection equipment are provided and sized properly for the devices being served and to supply such equipment with the proper protection. The Contractor shall verify that all MCC equipment will fit physically within the space allotted per the contract drawings.
- C. The motor control center manufacturer shall equip the assembly with all appurtenances and accessories (including but not limited to control relays, control contacts, control wiring, and terminal strips) as required for interface with the main control system to provide a totally integrated and operable system.

1.03 RELATED SECTIONS

- A. Section 26 29 23 – Variable Frequency Drives
- B. Section 26 80 00 – Control System

1.04 SUBMITTALS

- A. In accordance with the Submittal requirements of Section 26 05 00, the MCC manufacturer shall develop and submit to the following additional information:
- B. System wiring diagrams for each unit in the entire motor control center including but not limited to: all instruments, relays, starters, switches, lights, breakers terminals, etc. Diagrams shall indicate the terminals for remote devices as shown on the wiring diagrams in the contract drawings. Wire and terminal numbers shall be included on the schematic diagrams. Relay contacts shall be indicated for type and number available for each relay used.
- C. Information on ratings and sizes of all equipment such as control transformers, fuses, breakers, etc. on the wiring diagrams for each bucket including time current curves.
- D. Connection diagrams showing physical wiring layout for each unit.

- E. Technical data sheets for all components with the complete part number of the component clearly designated with all required options as specified in part 2.
- F. Scaled arrangement drawings of all panel front- and internal-mounted instruments, switches, devices, and equipment indicated. Show all mounting details required. Deviations from approved arrangements require resubmittal and approval prior to installation.
- G. Descriptive text on wire markers to be used.
- H. Bill of materials showing quantity, manufacturer, catalog number, and the supplier name and phone number for all components of the MCC.
- I. Shop Drawings shall be provided on 11" x 17" sheets (maximum) and shall be scaled using standard engineering or architectural scales.

1.05 COORDINATION OF EQUIPMENT

- A. The Contractor shall coordinate equipment information with the MCC manufacturer so that the correct type of motor starters and protection equipment are provided and sized properly for the devices being served and to supply such equipment with the proper protection.
- B. The Contractor shall verify that all MCC equipment will fit physically within the space allotted per the contract drawings, prior to ordering of equipment.
- C. Coordination with Control System
 - 1. The motor control center manufacturer shall equip the assembly with all appurtenances and accessories (including but not limited to control relays, control contacts, control wiring and terminal strips) as required by the Contractor for interface with the main control system to provide a totally integrated and operable system.
 - 2. The Contractor shall be solely and completely responsible for coordination and integration of control system with the motor control center.
- D. Operation and Maintenance Data
 - 1. Provide operation and maintenance data for all motor control center and related equipment in accordance to the general requirements in Section 26 05 00 and 26 80 00.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. The size of the MCC shown on the drawings is based on MCCs manufactured by Allen-Bradley. Motor control centers and VFDs shall be Allen-Bradley, no exceptions.
- B. The equipment of the manufacturer selected must fit within the space restrictions as shown on the plans.

2.02 CONSTRUCTION

A. General

1. Motor control centers shall be designed, assembled, tested and placed into operation by the MCC supplier. The motor control center shall fit into the space requirements as shown on the drawings. The contract drawings show general MCC layout and space requirements and may be modified by the MCC manufacturer if first approved by the Engineer.

B. Structure

1. The MCC shall consist of vertical sections that can be joined together to form a rigid free-standing, completely enclosed assembly. Vertical sections shall be fabricated of bolted No. 14 gage steel minimum. Each section shall have flange formed doors and/or covers both front and rear. Doors shall include provisions for padlocking all breakers in the open position.

C. MCC construction shall be suitable for the environment installed.

1. Damp or dusty areas: MCCs shall be NEMA 12 construction.
2. General purpose areas (all other areas not described above): MCC construction shall be NEMA 1 gasketed, unless specified otherwise on the plans.

D. Arrangement

1. Motor control center sections shall have a minimum 72-inch working height to accommodate a minimum of six 12-inch compartments. Sections shall be 20 inches deep with a 90-inch height. Minimum width shall be 20 inches. Compartments shall have pan-type doors with quarter turn hold-down latches and neoprene gaskets. Doors for compartments with starter and feeder tap units shall be mechanically interlocked with the unit's disconnect device to prevent unintentional opening of the door while energized and unintentional application of power while the door is open.
2. Starters and feeder tap units shall be draw-out plug-in construction with hardened, plated copper free-floating stabs, steel spring backups, and interference tabs which prevent door closure if unit is improperly installed. Units shall be latched to assure proper bus contact.

E. Finish

1. All steel parts shall be provided with an acrylic baked enamel paint finish, except plated parts used for ground connections. Painted parts shall be primed with a zinc-phosphate primer or undergo a phosphatizing pre-paint treatment for rust resistance and paint bond. Paint shall be applied by electrostatic process and baked to a durable hard finish. Exterior and structure color shall be ASA #49 gray. Starter bucket interiors shall be white.

F. Wiring / Terminals

1. The motor control center shall be suitable for operation on 240 volts, three-wire, 60 hertz. Wiring shall be NEMA Class II, Type B. Each unit shall be completely prewired with all control wiring numbered and terminated on terminal strips.

Terminal's numbering shall be coordinated between units such that like devices shall have the same terminal numbers. Wiring within one bucket shall be labeled with a basic wire numbering scheme.

2. A minimum of 5 spare terminals shall be provided in each unit. Terminal strips are not required for the load wiring. Auxiliary components, such as HOA selector switches, indicating lights and other indicating and/or recording devices, shall be mounted on the compartment door or cover. All control power leads into and out of each unit shall pass through auxiliary contacts of the circuit breaker or be equipped with their own disconnecting device or disconnecting terminal strips, appropriately labeled.

G. Wireways

1. Full height vertical wireway shall be provided in each MCC section that accepts modular plug-in units. The vertical wireway shall connect with both the top and bottom horizontal wireway. The vertical wireway shall be 4" for a 20" wide (9" for a 25") wide section with a separately hinged door. Structures that house a single, full section control unit are not required to have vertical wireways. Those control units must open directly into the motor control center horizontal wireways.

H. Bus

1. The motor control center bus shall be tin-plated copper with connections between vertical and horizontal power bus bars made with 3/8-inch bolts and conical dished steel washers. Access for tightening connections shall be from the front, without the need for tools on the rear of the connection.
2. Unless otherwise specified all sections shall contain horizontal and vertical busses. Each end of the line up shall be provided for connection of future sections.
3. Unless otherwise specified or required by the components installed, main horizontal bus shall be rated a minimum 600 amperes continuous, vertical bus shall be rated a minimum of 300 amperes continuous.
4. A 1/4" X 2" minimum un-plated copper ground bus shall be provided the full length of the motor control center. Ground bus shall be located at the bottom of the motor control center and shall contain lugs to terminate, as a minimum, two (one at each end of ground bus) 4/0 AWG bare copper ground conductors.

I. Motor Starter Units / Contactors

1. Motor starter units shall be of the combination type with components as indicated on the drawings. Magnetic contactors shall be heavy duty NEMA rated and shall be size 1 minimum. All contactors shall be provided with two field convertible auxiliary contacts. An auxiliary switch shall be provided to indicate the circuit breaker is in the "ON" position. Switch shall be open when the circuit breaker is open. Motor starters and associated equipment shall be provided to match the load being served.
2. Overload Relays
 - a. Thermal overload relays on starters shall be ambient compensated bi-

metallic type or solid state type with selector for either auto or manual reset. Overload Relays shall monitor all energized conductors. Overload relay shall be provided with a circuit test button which shall simulate an overload trip, trip indication, and reset pushbutton.

3. Control Transformers

a. Each control transformer shall be rated 240-120 volt, single phase, 2 wire, 60 hertz. The transformer shall be sized for the load it feeds but shall not be less than the minimum ratings as follows:

<u>NEMA starter size</u>	<u>Minimum transformer volt-ampere rating</u>
1	100
2	150
3	200
4	300
5	500

b. Each control transformer shall be provided with time-delay, slow blow secondary fuse rated to interrupt 10,000 amperes short circuit at 250 volts AC. Two primary fuses rated to interrupt 200,000 amperes at 600 volts shall be provided on all starters.

4. Transient Suppressors

a. All contactor coils shall be provided with transient suppressors to limit the high voltage transients produced when power is removed from the coil.

J. Circuit Breakers

1. General

a. Circuit breakers other than those mounted in the panelboard shall be capable of being padlocked in the open position.

2. Motor Circuit Protectors

a. Provide motor circuit protectors for all full voltage starters.

b. The molded case motor circuit protector shall operate on the magnetic principle with a current sensing coil in each of the three poles to provide an instantaneous trip for short circuit protection. The trip setting shall be adjustable from 700 to 1300 percent of the motor full load amperes from the front of the breaker. The motor circuit protector shall be set at its lowest position at the factory. All breakers for motor starters shall include auxiliary contacts which open when the breaker in the OFF position.

3. Thermal Magnetic

a. Provide thermal magnetic circuit breakers for all reduced voltage starters and variable frequency drives.

b. Circuit breakers shall be molded case thermal-magnetic type. Circuit breakers shall be quick-make and quick-break type. They shall have wiping type contacts. Each shall be provided with arc chutes, individual

trip mechanisms on each pole. Two and three pole breakers shall be common trip. All breakers shall be calibrated for operation in an ambient temperature of 40°C. Molded case circuit breakers shall be trip-free. Each breaker shall have separate trip indication independent of the ON or OFF positions.

K. Operating and Indicating Devices

1. See section 26 80 00 – Control System
2. Ammeter & Voltmeter
 - a. Voltmeter and voltmeter switch, ammeter and ammeter switch shall be provided where shown on the one-line diagram. Meters shall be analog type 4" nominal size, scaled for the application. Switches shall be instrument grade cam switches, rated for 25 ampere. Volt meter switch shall read phase to phase and phase to ground. Ammeter switch shall read phases A, B, and C. Provide three CTs for each ammeter.
3. Power Monitor and Display (PMD)
 - a. Power monitor and display unit shall be provided for each MCC. The unit shall monitor all three phases and shall display volts (phase to phase and phase to neutral), amperes, power factor, and hertz. The PMD shall be supplied with an Ethernet or equivalent for direct connection and communication to the PLC.
 - b. Power Monitors shall be Allen Bradley Power Monitor 1000.

L. Panelboard

1. Panelboards shall be provided in accordance to applicable requirements of Section 26 24 16.

M. Phase Loss Monitor (PLM)

1. The MCC shall be provided with phase failure relays wired for shutdown of 3-phase motors. It shall monitor phase loss, unbalance, low voltage and reverse phasing, with automatic reset. Each phase fail relay shall have 2 Form C contacts (DPDT).
2. PLM shall have undervoltage adjustment from 75-100%, response time delay set or adjustable between 3 and 5 seconds, phase unbalance set or adjustable between 5% and 10% and an LED indication for relay energized.
3. Sufficient control relays and wiring shall be supplied to provide one shutdown contact for each Full Voltage motor control circuit and 2 additional spare contacts.

N. Operating Mechanisms

1. All circuit breakers in motor control centers shall be provided with external "thru-the-door" operating handles.

PART 3 EXECUTION

3.01 GENERAL

- A. The Contractors shall verify that the motor starters, protection equipment, and other components, etc. provided are suitable (correct phase, voltage, starter type, correct breakers, and overload relays) for the motors and equipment loads being served.
- B. The motor control center shall be assembled per the Contractor's requirements, and shipped to the Contractor's shop. The Contractor shall complete the construction of the motor control center wiring and components per the contract documents. The motor control center shall be completely tested in the Contractor's shop and delivered to the site ready for external connections to field equipment.
- C. All assembly and wiring not completed by the manufacturer or Contractor due to shipping sections, multiple suppliers, etc. shall be the responsibility of the Contractor.
- D. Nameplates shall be mounted in a manner or location such that other equipment or devices do not block them so they are easily viewed.

3.02 TESTING

- A. The motor control center shall be tested in the Contractor's shop along with the control system. The testing shall include, but not be limited to, operation of all input and output (I/O) points, control devices and motor controllers.
- B. Testing and inspection of the motor control center shall include all components. All motor controllers shall be interconnected with the control system and powered with rated incoming voltage.

3.03 INSTALLATION

- A. The motor control system shall be installed in accordance with the installation drawings and manufacturer's instructions. Installation shall be performed by workers who are skilled and experienced in the installation of motor control equipment.

3.04 WIRING

- A. Refer to Section 26 05 19 for acceptable wiring types and methods.
- B. All signal and low voltage wiring shall be separated from 120 volt and 240 volt wiring and shall maintain a minimum of 1 inch separation of conductors.

*** END OF SECTION **

SECTION 26 27 26 – WIRING DEVICES

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section covers furnishing and installing all receptacles, switches and other wiring devices indicated on the drawings.

1.02 PRODUCTS

A. General

- 1. Wiring devices shall be UL approved for the current and voltage specified and shall comply with NEMA WD-1. Devices shall contain provisions for back wiring and side wiring with captively held binding screws. Devices shall be brown except those located in finished areas, which shall be ivory.

B. Receptacles and Plugs

1. General:

- a. Receptacles shall be grounding type.

2. 120 Volt Receptacles:

- a. Indoor Clean Areas: Receptacles shall be duplex 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps. Receptacles shall be Hubbell 5362 or equal.
- b. Ground Fault Circuit Interrupter (GFCI) receptacles: GFCI receptacles shall be provided in all areas as required by local codes and NEC article 210.8. Hubbell GF-5362, or equal.
- c. Outdoor, Process or Corrosive Areas: Receptacle shall be duplex, 20 ampere, NEMA 5-20R, and shall accept NEMA 5-15P and 5-20P plug caps. Receptacle and plug caps shall be corrosion resistant. Covers shall be rated for “while-in-use” and installed per manufacturer’s directions. Manufacturer shall be Hubbell Series WP, or approved equal.

C. Switches

1. General Purpose (Indoor, Clean Areas):

- a. General purpose switches shall be quiet AC type, specification grade, and shall be provided in accordance with rated capacities as required. Switches shall match receptacles in color. Switches shall be manufactured by General Electric, Hubbell, or equal.

2. Switches for Outdoor and Corrosive Areas

- a. Switches shall be 20 amp with weatherproof/corrosion resistant neoprene plate as manufactured by Hubbell, Arrow-Hart, or equal.
- b. Switches shall be mounted in "FS" type copper-free aluminum or PVC mounting boxes.

D. Device Plates

1. Device plates shall be provided with switches. In noncorrosive indoor areas, receptacle device plates shall be made of sheet steel, zinc electroplated with chrome finish. Device plates in corrosive or outdoor areas shall be corrosion-resistant type. Device plates for explosion-proof equipment shall be factory provided with the equipment.
2. Device plates shall be provided with engraved laminated phenolic nameplates with 1/8 inch white characters on black background. Nameplates for switches shall identify panel and circuit number and area served. Nameplates for receptacles shall identify circuit and voltage if other than 120 volts, single phase.

PART 2 EXECUTION

2.01 GENERAL

- A. Boxes shall be independently supported by galvanized brackets, expansion bolts, toggle bolts, or machine or wood screws as appropriate. Wooden plugs inserted in masonry or concrete shall not be used as a base to secure boxes, nor shall welding or brazing be used to attachment. Wiring devices shall be tested for correct connections.
- B. Position of Outlets
 1. All outlets shall be centered with regard to building lines, furring and trim, symmetrically arranged in the room. Set outlets shall be set plumb and extend flush outlets to the finished surface of the wall, ceiling or floor without projecting beyond same. All receptacles, switches and outlets shown on the drawings shall be installed symmetrically along trim and where necessary, set the long dimension of the plate horizontal or gang in tandem.
- C. Mounting Heights
 1. Unless otherwise noted, wall mounted outlet devices shall generally be 24 inches above the floor, 18 inches in architecturally treated areas. Switches shall be 48 inches above the floor. All measurements are to centerline of device.

*** END OF SECTION ***

SECTION 26 28 16 – DISCONNECTS AND SWITCHES

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section specifies all disconnects, fused and unfused, required by code for equipment furnished under this and other Divisions of these specifications.

1.02 STANDARDS AND CODES

- A. All equipment, materials, and the design, construction, installation, and application thereof shall comply with all applicable provisions of the national electrical code (NEC), the occupational safety and health act (OSHA), and any applicable federal, state, and local ordinances, rules and regulations. All materials and equipment specified herein shall be within the scope of nationally recognized testing laboratory (NRTL) examination services, be approved by the NRTL for the purpose for which they are used, and shall bear the appropriate listing label.

1.03 SUBMITTALS

- A. Submit all catalog data In accordance with the Submittals requirements in Section 26 05 00.1.12. Show material information and confirm compliance with these Specifications.

PART 2 PRODUCTS

2.01 DISCONNECTS

- A. Disconnect switches shall be heavy duty type, shall be horsepower rated, quick-make, quick-break construction. Switch blades shall open all ungrounded conductors and shall be single throw, unless otherwise noted.
- B. Disconnect switch enclosures shall be NEMA rated and mounted in accordance with Section 26 05 00.1.10.
- C. Fusible disconnects shall be as specified above with fuse space and clips to accept Class R fuses. Fusible disconnects shall only be utilized where required by equipment manufacturer to meet UL installation requirements.

2.02 MANUFACTURER

- A. Disconnect switches shall be manufactured by Cutler Hammer, Square D, Westinghouse, or equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Switches shall be mounted at locations shown on plans. Installation shall be in

accordance with the following methods:

1. Mounting
 - a. Disconnects shall be fastened securely to supporting structure at walls and stands:
 - b. Wood screws or lag screws to wood boards or timbers
 - c. Machine bolt to metal framing or plates
 - d. Expansion anchors to concrete walls
 - e. Expansion toggle wing bolts or sleeve anchors to hollow block
 - f. Provide 1 inch spacers to set enclosure out from concrete or block wall
2. Stands and Supports
 - a. Disconnect stands and support shall be constructed of and secured by:
 - b. Corrosion-resistant materials and finishes
 - c. Unistrut-type materials for fabrication
 - d. Expansion anchors for bolts in concrete floor
 - e. Machine bolt to metal framing or plates
 - f. Wood screws or lag screws to wood boards or timber
 - g. Backing plate for mounting units.
 - h. Fasten stand securely to floor
 - i. Dimensions as required by equipment to be mounted
3. Arrangement
 - a. Disconnects shall be arranged for driven equipment use or function:
 - b. Similar units adjacent
 - c. Adequate space for operation and servicing
4. Mounting Height
 - a. Center of handle shall be 4 feet 6 inch above the finished floor or work platform.

3.02 IDENTIFICATION

- A. Nameplates shall be provided for all disconnects in accordance with Section 26 05 00.2.2.
- B. Nameplate to state load designation and power source equipment.

*** END OF SECTION ***

SECTION 26 29 23 – VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This section specifies AC pulse width modulated (PWM) Variable Frequency Drives (VFD) for operation on 480 Volt, three phase, 60 cycle power.
- B. Provider of VFDs
 - 1. The VFDs shall be provided by the System Integrator.
 - 2. The VFD's shall be provided as a complete and operational system, integral to the MCC or other control panels, as shown on the drawings.

1.02 SUBMITTALS

- A. Submit all catalog data in accordance with the Submittals requirements in Section 26 05 00. Show material information and confirm compliance with these specifications.
- B. In addition to the requirements of Section 26 05 00, submittals shall include the following information:
 - 1. Outline Dimensions with exterior and interior equipment elevation drawings.
 - 2. Wiring diagrams with all interface points and terminal numbers clearly identified.
 - 3. Specific information on the VFDs components provided for this project and all optional equipment provided.
 - 4. Operations and programming manual.
- C. Warranty
 - 1. The Contractor shall guarantee the VFDs to be free of defects in design, materials and workmanship for a period of one (1) year following the date of acceptance, of all work under the contract. The guarantee shall include all parts and labor and shall be secured by a written guarantee from the Manufacturer to the Owner. The written guarantee shall be delivered to the Owner prior to date of acceptance of all work under the Contract.

PART 2 PRODUCTS

2.01 GENERAL

- A. The Variable Frequency Drive (VFD) motor controller shall convert 480 Volt, three-phase, 60 Hertz power to adjustable voltage (480 volt) and frequency (0 - 60 hertz) three-phase, AC power for motor speed control with a capability of 60:1 speed range. All general options and modifications shall mount within the standard adjustable frequency controller enclosure.
- B. The controller(s) shall be suitable for use with any standard configuration squirrel-cage

induction motor(s) having a 1.15 Service Factor, or with existing standard squirrel-cage induction motor(s) with nameplate data as shown on the plans. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage, and RPM) in the field.

2.02 SERVICE CONDITIONS

- A. The VFD shall be designed and constructed to operate within the following service conditions:
1. Ambient Temperature Range: -10°C to 40°C
 2. Atmosphere: Non-Condensing relative humidity to 95%
 3. AC Line Voltage Variation: $\pm 10\%$
 4. AC Line Frequency Variation: ± 3 Hertz

2.03 BASIC DRIVE

- A. Description
1. The VFD shall produce an adjustable AC voltage/frequency output. It shall have an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.
 2. The VFD shall have a continuous output current rating of 100% of motor nameplate current.
 3. The VFD shall be of the Pulse Width Modulated type and employ a dual full-wave diode bridge converter to convert incoming fixed voltage/frequency to a fixed DC voltage. The Pulse Width Modulation strategy shall be of the space vector type implemented in a microprocessor which generates a sine-coded output voltage.
 4. The inverter output shall be generated by Insulated Gate Bipolar Transistors (IGBT) which shall be controlled by six identical base driver circuits. The worst case RMS motor line current measured at rated speed, torque and voltage shall not exceed 1.05 times the rated RMS motor current for pure sine wave operation.

2.04 KEYPAD OPERATOR INTERFACE

- A. The VFD shall be provided with a door mounted LCD keypad which will indicate (minimum):
1. Frequency output
 2. Voltage output
 3. Current output
 4. Motor RPM
 5. Motor kW
 6. Elapsed Time
 7. Time stamped fault indication

8. DC bus Volts
9. Faults
10. Parameter settings.

2.05 ENCLOSURE

- A. All VFD components shall be factory mounted and wired in an enclosure, meeting the requirements of 26 05 00, Area Classifications.
- B. A ventilation system shall be provided to maintain the internal enclosure temperature within the operating conditions for the VFD.
- C. If a free-standing enclosure is provided, it shall be suitable for mounting on a concrete housekeeping pad.

2.06 PROTECTIVE CIRCUITS AND FEATURES

- A. The VFD shall include the following protective circuits and features:
 1. Overload rating of 110% for 60 seconds, and 150% for 3 seconds.
 2. Output phase to phase short circuit condition.
 3. Total ground fault under any operating condition.
 4. High input line voltage
 5. Low input line voltage
 6. Loss of input or output phase
 7. Metal Oxide Varistors for surge suppression at the VFD input terminals.
- B. Diagnostic Features
 1. The VFD shall include a microprocessor based digital diagnostic system which shall monitor its own control functions and displays faults and operating conditions.
 2. A "FAULT LOG" shall record, store, and display the fifty (50) most recent fault events.
 3. Ethernet communications shall be provided on each VFD for connection to PLC and SCADA systems for monitoring and control.
- C. Acceptable Manufacturers
 1. Acceptable Manufacturers shall provide equipment which meets all of the requirements of these specifications, and fit within the space requirements.
 2. Where VFDs are mounted integral to an MCC assembly, the MCC and VFD manufacturers shall be the same.
 3. VFD's shall be Allen Bradley Powerflex 753 series, or Engineer approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Installation shall be the responsibility of the Contractor. The Contractor shall install the drive in accordance with the contract drawings and as recommended by the VFD Manufacturer as outlined in the installation manual.
- B. Power and control wiring shall be completed by the Electrical Contractor. The Contractor shall complete all wiring in accordance with the recommendations of the VFD Manufacturer as outlined in the installation manual.

3.02 QUALITY ASSURANCE

- A. The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:
 - 1. Each VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase, current, voltages and motor speed. Correct current limiting operation shall be verified by simulating a motor overload. Manufacturing test data shall be recorded and stored by the manufacturer at the time of production.
 - 2. Verification of proper factory presets shall be performed on 100% of all parameters to ensure proper microprocessor settings. Verification that the proper factory settings are loaded correctly in the drive shall be done via the drive serial interface port.
 - 3. The drive assembly shall be tested for shock (15G peak for 11 ms duration) and vibration (-0152 mm displacement, 1G peak).

3.03 START-UP

- A. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Engineer, Owner, and a copy kept on file at the Manufacturer. Cost for this startup support shall be included in the VFD bid price. The Engineer shall be notified a minimum one (1) week in advance of the scheduled start-up.
- B. Where the application utilizes standby power generation, the VFDs shall be tested with both Utility and standby power sources. The VFD Representative shall make any and all adjustments and modifications to the VFDs to operate within specified limits, without additional cost to the owner. The Manufacturer's representative will be present during these tests.
- C. A list of all drive parameters and settings for each drive shall be provided to the Owner upon project completion.

3.04 OPERATION AND MAINTENANCE TRAINING

- A. The Supplier shall conduct specifically organized training sessions in operation and maintenance of the VFD equipment for personnel employed by the Owner. The training

sessions shall be conducted to educate and train the personnel in maintenance and operation of all components of the system. Training shall include, but not be limited to, the following:

1. Preventative maintenance procedures
2. Trouble-shooting
3. Calibration
4. Testing
5. Replacement of components.

- B. At least one (1) training session, of at least four (4) hours in duration, shall be conducted after start-up of the system. The Supplier shall provide specific instruction materials for each training session and shall supply such materials to the Owner at least one (1) week prior to the time of the training.

*** END OF SECTION ***

SECTION 26 32 13 – DIESEL EMERGENCY ENGINE GENERATORS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes packaged diesel engine generators for emergency use with the following features:
 - 1. Diesel engine.
 - 2. Diesel fuel-oil system.
 - 3. Control and monitoring.
 - 4. Generator overcurrent and fault protection.
 - 5. Generator, exciter, and voltage regulator.
 - 6. Load banks.
 - 7. Outdoor engine generator enclosure.
 - 8. Vibration isolation devices.
 - 9. Finishes.
- B. Related Requirements:
 - 1. Section 263600 "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.03 DEFINITIONS

- A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set can deliver in the event of a utility power outage or under test conditions for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.
- B. Operational Bandwidth: The total variation, from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 2. Include thermal damage curve for generator.
 3. Include time-current characteristic curves for generator protective device.
 4. Include fuel consumption in gallons per hour (liters per hour) at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
 6. Include airflow requirements for cooling and combustion air in cubic feet per minute (cubic meters per minute) at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F (35, 27, 21, and 10 deg C). Provide Drawings indicating requirements and limitations for location of air intake and exhausts.
 7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.
- B. Shop Drawings:
1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Identify fluid drain ports and clearance requirements for proper fluid drain.
 4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and supported equipment. Include base weights.
 6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.
- C. Certifications:
1. Submit statement of compliance which states the proposed products are certified to the emissions standards required by the location for Eastsound, WA.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Manufacturer and testing agency.
- B. Source Quality-Control Reports: Including, but not limited to, the following:
 - 1. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
 - 2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
 - 3. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 - 4. Report of sound generation.
 - 5. Report of exhaust emissions showing compliance with applicable regulations.
 - 6. Certified Torsional Vibration Compatibility: Comply with NFPA 110.
- C. Field quality-control reports.
 - 1. Warranty: Submit manufacturer's warranty statement to be provided for this Project.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).
- F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

1.07 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 33 00 "Submittal Procedures", include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to generator location.
 - c. Training plan.

1.08 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 4. Tools: Each tool listed by part number in operations and maintenance manual.

1.09 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Testing Agency Qualifications: Accredited by NETA.
 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.010 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: 0.0 deg C (32.0 deg F) to 25.0 deg C (77.0 deg F).
 2. Relative Humidity: 0 to 95 percent.
 3. Altitude: Sea level to 100.0 feet.
 4. Close proximity to salt water and related environment.

1.011 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, generator model C125D6D.
- B. Pre-approved generator equipment manufacturers are Cummins, Kohler, Caterpillar, and Generac.
- C. Equals will be considered if equipment performance is shown to meet the specifications and requirements herein.
- D. Source Limitations: Obtain packaged engine generators and auxiliary components from single source from single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. B11 Compliance: Comply with B11.19.
- B. NFPA Compliance:
 - 1. Comply with NFPA 37.
 - 2. Comply with NFPA 70.
 - 3. Comply with NFPA 99.
 - 4. Comply with NFPA 110 requirements for Level 2 EPSS.
- C. UL Compliance: Comply with UL 2200.
- D. Engine Exhaust Emissions: Comply with EPA Tier 3 requirements and applicable state and local government requirements.
- E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator, including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

2.03 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- C. Capacities and Characteristics:
1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 150.0kW, at 80 percent lagging power factor, 277/480, Series Wye, Three phase, 4 -wire, 60 hertz.
 2. Alternator shall be capable of accepting maximum 920.0 kVA in a single step and be capable of recovering to a minimum of 90% of rated no load voltage. Following the application of the specified kVA load at near zero power factor applied to the generator set.
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.
- D. Generator-Set Performance:
1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 14 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 2 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Not more than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 2 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.
 6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
 7. Sustained Short-Circuit Current: (For engine-generator sets using a PMG-excited alternator) For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not less than 8 seconds without damage to generator system components. For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.

8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.04 ENGINE

- A. Fuel: ASTM D975 #2 Diesel Fuel
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions
- E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
 1. Designed for operation on a single 120 VAC, Single phase, 60Hz power connection. Heater voltage shall be shown on the project drawings.
 2. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
 3. Provided with a 12VDC thermostat, installed at the engine thermostat housing
- G. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.
- H. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
 2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.
- I. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.
- J. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.
- K. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
 2. Cranking Cycle: As required by NFPA 110 for level 1 systems.
 3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
 4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
 5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batteries with all parasitic loads connected within 4 hours after a normal engine starting sequence.

6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - f. Enclosure and Mounting: NEMA, Type 4, mounted in enclosure.

2.05 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be listed and labeled. The fuel tank shall include the following features:
 1. Capacity: Fuel for 35 hours continuous operation at 100 percent rated power output; 48 hours operation at normal operational output.
 2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
 3. Electrical stub up(s)
 4. Normal & emergency vents
 5. Lockable fuel fill

6. Mechanical fuel level gauge
7. High and low level switches to indicate fuel level
8. Leak detector switch
9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
10. Fill port with overfill prevention valve (OFPV)
11. 5 gallon fill/spill dam or bucket
12. Tank design shall meet the regional requirements for the Project location
13. Contractor shall provide diesel fuel for all required testing and provide the Owner with a full tank of diesel fuel upon final completion of the project.

2.06 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 1. AC voltmeter (3-phase, line to line and line to neutral values).

2. AC ammeter (3-phases).
3. AC frequency meter.
4. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
5. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
6. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
7. DC voltmeter (alternator battery charging).
8. Engine-coolant temperature gauge.
9. Engine lubricating-oil pressure gauge.
10. Running-time meter.
11. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
12. Fuel tank derangement alarm.
13. Fuel tank high-level shutdown of fuel supply alarm.
14. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR over current, loss of voltage reference, and over excitation shutdown protection. There shall be a overload warning, and overcurrent warning alarm.
15. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
16. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
17. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.

18. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
19. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).
20. Paralleling Breaker control switches: The control shall include manual open and close provisions for the paralleling breaker, and LED status lamps indicating whether the breaker is open or closed.

2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 125 / Class H environment.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Permanent Magnet Generator (PMG) shall provide excitation power for optimum motor starting and short circuit performance.
- G. Enclosure: Drip-proof.
- H. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 15 percent maximum, based on the rating of the engine generator set.

2.08 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Sound Attenuated Aluminum housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:

1. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 2. Exhaust System:
 - a. Muffler Location: Within enclosure.
 3. Hardware: All hardware and hinges shall be stainless steel.
 4. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
 5. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.
1. Louvers: Fixed-engine, cooling-air inlet and discharge.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 72 dBA measured at any location 7 m from the engine generator in a free field environment.
- E. Site Provisions:
1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.09 VIBRATION ISOLATION DEVICES

- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.010 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

2.011 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected

to actual prototype tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
 - 2. Full load run.
 - 3. Maximum power.
 - 4. Voltage regulation.
 - 5. Steady-state governing.
 - 6. Single-step load pickup.
 - 7. Simulated safety shutdowns.
 - 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Construction Manager and Owner no fewer than two working days in advance of proposed interruption of electrical service.

2. Do not proceed with interruption of electrical service without Owner's written permission.

3.03 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.
- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.04 CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Section 260519 "Wire and Cable." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- C. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.05 IDENTIFICATION

- A. Identify system components according to Section 260553 "Identification for Electrical Systems."
- B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.

3.06 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.

3.07 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
 - 1. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 - 2. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
 - 3. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.08 SERVICE AND SUPPORT

- A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with critical replacement parts. The service organization shall be on call 24 hours per day, 365

days per year. The service organization shall be physically located within 200 miles of the site.

- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.09 GENERATOR FUEL

- A. All diesel fuel for all testing of the generator shall be provided by the Contractor.
- B. After all testing has been completed to the satisfaction of the Owner and Engineer, the Contractor shall provide a full tank of diesel fuel to the Owner upon final commissioning.

3.010 TRAINING

- A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided.
- B. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons.
- C. Training date shall be coordinated with the facility Owner.

*** END OF SECTION ***

SECTION 26 36 00 – AUTOMATIC TRANSFER SWITCHES

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes Service Rated Automatic Transfer Switches (ATS) rated 600 V and less.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.
 - 3. Single-Line Diagram: Show connections between transfer switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
 - 4. Retain and revise, if necessary, "Riser Diagram" Subparagraph below if retaining remote annunciators, control panels, or bypass/isolation switches.
 - 5. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.06 QUALITY ASSURANCE

A. Testing Agency Qualifications:

1. Member company of NETA.
 - a. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.07 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.08 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: The basis for this specification is Cummins Power Generation equipment, transfer switch model OTECSE with NEMA 12 enclosure and Power Command 40-01 controller.
- B. Switches manufactured by other manufacturers that meet the requirement of this specification are acceptable, if approved not less than two weeks before scheduled bid date. Proposals must include a line-by-line compliance statement based on this specification.
- C. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.02 GENERAL TRANSFER SWITCH PRODUCT REQUIREMENTS

- A. Provide transfer switches in the number and ratings that are shown on the drawings.
- B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.

- C. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.
- D. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions.
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 - 1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.
 - 2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.
 - 3. Main switch contacts shall be high pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
 - 4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.
 - 5. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
 - 6. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.
 - a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality
 - 7. Transfer switches designated on the drawings as "3-pole" shall have a full current-rated neutral bar with lugs.
 - 8. Transfer switches designated on the drawings as "service entrance" switches shall meet the requirements of section "SERVICE ENTRANCE TRANSFER SWITCHES" of this specification.

- H. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism
- I. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.
- J. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:
 - 1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.
 - 2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.
 - 3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.

2.03 AUTOMATIC TRANSFER SWITCHES

- A. Comply with requirements for Level 1 equipment according to NFPA 110.
- B. Indicated current ratings:
 - 1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
 - 2. Main contacts shall be rated for 600 VAC minimum.
 - 3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).
- C. Relay Signal: Control shall include provisions for addition of a pre-transfer relay signal, adjustable from 0 to 60 seconds, to be provided if necessary for elevator operation, based on equipment provided for the project.
- D. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.
- E. Automatic Transfer Switch Control Features

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
 2. All transfer switch sensing shall be configurable from an operator panel or from a Windows PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.
 3. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 60 seconds.
 4. The control system shall be designed and prototype tested for operation in ambient temperatures from - 40 degrees C to + 60 degrees C (- 40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
 5. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
 6. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery-based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational.
- F. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. The panel shall also include an alphanumeric display for detailed system information. Panel display and indicating lamps shall include permanent labels. The control shall be PowerCommand 40-01 or approved equal.
1. The indicator panel LEDs shall display:
 - a. Which source the load is connected to (Source 1 or Source 2)
 - b. Which source or sources are available
 - c. When switch is not set for automatic operation, the control is disabled
 - d. When the switch is in test/exercise mode
 2. The indicator shall have pushbuttons that allow the operator to activate the following functions:
 - a. Activate pre-programmed test sequence
 - b. Override programmed delays, and immediately go to the next operation
 - c. Reset the control by clearing any faults

- d. Test all of the LEDs by lighting them simultaneously
3. The alphanumeric digital display shall be LCD, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:
 - a. AC voltage for all phases, normal and emergency
 - b. Source status: connected or not connected.
 4. The display panel shall be password-protected, and allow the operator to view and make adjustments:
 - a. Set nominal voltage and frequency for the transfer switch
 - b. Adjust voltage and frequency sensor operation set points
 - c. Set up time clock functions
 - d. Set up load sequence functions
 - e. Enable or disable control functions including program transition
 - f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history
- G. Control Functions: Functions managed by the control shall include:
1. Software adjustable time delays:
 - a. Engine start (prevents nuisance genset starts in the event of momentary power fluctuation): 0 to 120 seconds (default 3 sec)
 - b. Transfer normal to emergency (allows genset to stabilize before load is transferred): 0 to 120 seconds (default 3 sec)
 - c. Re-transfer emergency to normal (allows utility to stabilize before load is transferred from genset): 0 to 30 minutes (default 3 sec)
 - d. Engine cooldown: 0 to 30 minutes (default 10 min)
 - e. Programmed transition: 0 to 60 seconds (default 3 sec)
 2. Voltage imbalance sensing:
 - a. Dropout: 2 to 10% (default 4%)
 - b. Pickup: 90% of dropout
 - c. Time delay: 2.0 to 20 seconds (default 5 sec)

- d. Bar graph meter panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.
- 3. Phase rotation sensing:
 - a. Time delay: 100 msec
- 4. Loss of single-phase detection:
 - a. Time delay: 100 msec
- H. Control features shall include:
 - 1. Programmable genset exerciser: A field-programmable control shall periodically start and run the generator with or without transferring the load for a preset time period, then re-transfer and shut down the generator after a preset cool-down period.
 - 2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.
 - 3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.
 - 4. Re-Transfer Inhibit Switch: Inhibits automatic re-transfer control so automatic transfer switch will remain connected to emergency power source as long as it is available regardless of condition of normal source.
 - 5. Transfer Inhibit Switch: Inhibits automatic transfer control so automatic transfer switch will remain connected to normal power source regardless of condition of emergency source.
- I. Control Interface
 - 1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
 - 2. Unassigned Auxiliary Contacts: Two normally open, 1-pole, double-throw contacts for each switch position, rated 10A at 240 VAC.
- J. Engine Starting Contacts
 - 1. One isolated and normally closed pair of contacts rated 10A at 32 VDC minimum.

2.04 SERVICE ENTRANCE TRANSFER SWITCHES

- A. Transfer switches must be specifically intended for service entrance applications, and labeled "Suitable for service entrance use only"
- B. Transfer switch shall meet NEC requirements for emergency, legally required and standby applications as specified in UL 1008.
- C. Entire transfer switch including enclosure must be listed and labeled to UL 1008; switches with only the mechanism listed are not acceptable.
- D. Molded case circuit breaker must be UL 489 listed.

2.05 SOURCE QUALITY CONTROL

- A. Prepare test and inspection reports.
 - 1. For each of the tests required by UL 1008, performed on representative devices, for emergency systems. Include results of test for the following conditions:
 - a. Overvoltage.
 - b. Undervoltage.
 - c. Loss of supply voltage.
 - d. Reduction of supply voltage.
 - e. Alternative supply voltage or frequency is at minimum acceptable values.
 - f. Temperature rise.
 - g. Dielectric voltage-withstand; before and after short-circuit test.
 - h. Overload.
 - i. Contact opening.
 - j. Endurance.
 - k. Short circuit.
 - l. Short-time current capability.
 - m. Receptacle withstand capability.
 - n. Insulating base and supports damage.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint requirements.
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 - 1. Floor-mounted transfer switches shall be mounted on concrete bases complying with the following requirements:
 - a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support.
- C. Identify components according to Division 26 Section "Identification for Electrical Systems."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
 - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- F. Route and brace conductors according to manufacturer's written instructions. Do not obscure manufacturer's markings and labels.

3.03 SOURCE QUALITY CONTROL

- A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.
- B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

- C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.04 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.
- B. Manufacturer's representative shall perform tests and inspections and prepare test reports.
- C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.
 - 1. Perform recommended installation tests as recommended in manufacturer's installation and service manuals.
 - 2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Verify time-delay settings.
 - c. Verify that the transfer switch is accurately metering AC voltage.
 - d. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 DEMONSTRATION

- A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.

1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.
2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

3.06 SERVICE AND SUPPORT

- A. The manufacturer shall supply the Service Provider with a complete set of the service and maintenance software required to support the product. The software shall be provided at a training class attended by the user, to qualify the user in proper use of the software. The software shall have the following features and capabilities:
 1. The software shall allow adjustment of all functions described herein, adjustment of operating levels of all protective functions, and programming of all optional functions in the controller. Adjustments shall be possible over modem from a facility that is remote from the generator set.
 2. The software shall be capable of storing and displaying data for any function monitored by the generator set control. This data shall be available in common file formats, and on graphical "strip chart" displays.
 3. The software shall automatically record all control operations and adjustments performed by any operator or software user, for tracking of changes to the control.
 4. The software shall display all warning, shutdown, and status changes programmed into transfer switch controller. For each event, the control shall provide information on the nature of the event, when it last occurred, and how many times it has occurred.

END OF SECTION

SECTION 26 51 19 – LED LIGHTING

PART 1 GENERAL

1.01 SCOPE

- A. Provide lighting equipment complete and operational as indicated on the plans. All fixtures are to be new, complete with lamps and fully operational in conformance with code and U.L. listing requirements.

1.02 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 01, General Requirements, apply to this Section.

1.03 CATALOG NUMBERS

- A. Model and series numbers indicate design intent in terms of fixture quality and general requirements. The actual fixtures submitted shall correspond with the number of lamps, wattage, ceiling type and any other specific performance and installation requirements specified or shown on drawings. Verify actual requirements prior to ordering fixtures.
- B. Light fixture schedule series numbers are a design series reference and do not necessarily represent the exact catalog number, size, voltage, wattage, type of lamp, ballast, finish trim, ceiling type, mounting hardware, ceiling trim or special requirements as specified hereinafter or as required by the installations. Provide complete fixtures to correspond with the number of lamps, wattage and/or size specified.
- C. If there are discrepancies between fixture illustrations and the written description in the fixture schedule, the written description in the fixture schedule shall take precedence.

1.04 SUBSTITUTIONS

- A. Substitutions will be allowed for fixtures listed on the lighting fixtures schedule as ‘or equal’, with Engineer approval.
- B. Proposed substitutions shall include complete photometric calculations in plan view showing lighting levels based on proposed fixtures.
- C. Final determination of equivalence shall be by the Engineer.

1.05 REFERENCES

- A. National Electrical Manufacturer’s Association (NEMA) LE5-1993: Procedure for determining Luminaire efficiency ratings.
- B. Underwriters Laboratories, Inc. (UL).
- C. Washington State Energy Code, WSEC latest edition, and WAC 51-11C.

1.06 SUBMITTALS

- A. For standard catalog items, provide original product sheets, to indicate that light fixtures and accessories fully comply with contract documents. Include photometric report by an independent certified testing laboratory when required in fixture schedule. Manufacturer's test report is not acceptable.
- B. Submittals shall have fixture types and project name clearly indicated and shall be prepared by the authorized manufacturer's representative serving the project area. A list of manufacturer's representatives (including address, telephone and fax numbers) identifying which light fixture types they represent shall be included with submittals. Submittals or requests for substitutions not meeting these requirements will be rejected.
- C. Product samples complete with housing, trim, plug, and specified lamp shall be submitted upon request.
- D. Submit lighting control devices as required by Washington State Energy Code

1.07 QUALITY ASSURANCE

- A. Fixtures and components shall be new and listed by Underwriters Laboratories (UL) or other testing lab acceptable to local jurisdiction.

1.08 WARRANTY

- A. LED Lamp Technology: Provide manufacturer's warranty for a period of not less than five years including parts and labor for full replacement of defective product.

PART 2 PRODUCTS

2.01 GENERAL MATERIAL REQUIREMENTS

- A. Fixtures shall be free of light leaks and designed to provide sufficient ventilation of lamps to provide the photometric performance required.
- B. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. Intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. Finish exposed edges so no sharp or ragged edges are exposed. All miters shall be in accurate alignment with abutting intersecting members.
- C. Lamp holders shall hold lamps securely against normal vibrations and maintenance handling.
- D. Exterior Fixtures
 - 1. Painted surfaces shall have an outdoor life expectancy of not less than 20 years without any visible rust or corrosion.
 - 2. Diffusing materials shall be UV stabilized.
 - 3. Finish colors shall be as specified.

2.02 LIGHTING CONTROLS

- A. Provide lighting controls including switches, contactors, occupancy sensors etc where indicated on the drawings and schedules.
- B. Lighting controls shall be provided to conform with the latest version of WSEC Energy Code requirements in Washington State. Electrical Contractor shall submit Code-compliant materials, fixtures, and control devices.

PART 3 EXECUTION

3.01 LIGHTING FIXTURES, GENERAL

- A. Provide mounting accessories and trims as required for wall and ceiling construction types shown in Finish Schedule and on Drawings. The lighting fixture schedule does not differentiate between grid and flange mounting. The contractor shall review the architectural reflected ceiling plan to confirm locations where flange or other special mounting conditions are applicable.
- B. Verify weight and mounting method of fixtures and provide suitable supports. Fixture mounting assemblies shall comply with local seismic codes and regulations.
- C. Refer to architectural reflected ceiling plans for coordination of lighting fixtures with mechanical and fire safety equipment. Where conflicts occur, coordinate with Architect prior to installing lighting fixtures.
- D. Install lighting fixtures such that vent holes are free of air blocking obstacles.
- E. Recessed lighting fixtures located in ceilings with fire resistive rating of one hour or more shall be enclosed in an approved fire resistive enclosure with a rating equal to that of the ceiling.
- F. Adjust finish trim rings on all recessed fixtures to be flush and level with the finished ceiling.
- G. Adjust variable position lamp holders for proper lamp position.
- H. Replace all burned out or inoperative lamps at the end of the construction prior to Owner occupancy.
- I. Test and demonstrate lighting control system, as applicable.

*** END OF SECTION ***

SECTION 26 80 00 – CONTROL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

- A. This Section covers includes the general requirements for furnishing, installing, programming, adjusting, testing, documenting and commissioning of the complete and operational Instrumentation, SCADA and PLC based control system.
- B. The control system includes the complete instrumentation, PLC's and control panels, Motor Control Center, operator interface, and SCADA system and related equipment for complete monitoring and control of the entire facility treatment system.
- C. Major components of this system include, but are not limited to, all materials, equipment, and work required to implement a complete and operating system as described herein. The system shall include primary elements for process variable measurements, control elements, analog displays, communication systems, and all hardware and software required to program, calibrate and monitor the instrumentation, communication and control devices.
- D. The Contractor shall provide, program, calibrate, test and commission the complete and operational Instrumentation, SCADA and PLC based control system.
- E. The Contractor shall place the completed system in operation, including programming, tuning loops, testing and adjusting communications and making final adjustments to instruments and equipment as required during system start-up. The Contractor shall provide the services of trained and qualified instrument technicians for these services.

1.02 RELATED SECTIONS

- A. 26 05 00 – Electrical General
- B. 26 29 23– Variable Frequency Drives
- C. 26 24 19 – Motor Control Centers

1.03 DEFINITION OF TERMS

- A. General – Refer to Standard abbreviations, Section 26 05 00.3.7.
- B. PLC – Programmable Logic Controller. Industrial computer system that interfaces with instrumentation and equipment and allows for automated control of process equipment.
- C. OIU – Operator Interface Unit. Local display to display graphical status of instrumentation and equipment status, alarm monitoring, set point control and visualization.
- D. SCADA – Supervisory Control And Data Acquisition computer system. Computer based system with custom software to allow for supervisory monitoring and control, data logging, alarm monitoring and reporting for the overall facility control and treatment system.

- E. Contractor: The party who furnishes and installs all tools, materials, and equipment to complete the work shown and implied in the drawings and these specifications. This includes the Prime Contractor, the Electrical Contractor, System Integrator, Telecom Contractor, and all other Contractors and Subcontractors.
- F. System Integrator: An organization engaged in the business of detail design, component selection and procurement, fabrication, wiring, assembly, programming and testing process control and telemetry systems. The System Integrator will provide the programming, licensing and software development for the PLC and SCADA process control system for this project.
- G. Telecom Contractor: The telecommunications company responsible for all data cabling equipment and testing. This includes all communications cabling shown on the plans. Telecom contractor shall be selected by the Contractor.
- H. Equipment Supplier: The equipment manufacturing company of packaged treatment or other specialty systems and components, furnished by the Equipment Supplier and installed by the Contractor, responsible for providing all materials, equipment, and testing for a fully operational system.

1.04 SPECIAL REQUIREMENTS

- A. The Contractor shall install components including those assembled by the System Integrator at the locations shown in the plans, and in accordance with the requirements of Division 26.
- B. The Contractor shall be responsible for the selection of the System Integrator, and shall be subject to approval by the Engineer. It is recommended that the System Integrator be a control system manufacturing company that conforms to the following requirements:
 - 1. The System Integrator shall be specialized in the design, assembly, programming, testing, installation and service of municipal control and communication systems in the Pacific Northwest for at least the last five years.
 - 2. The System Integrator shall employ technicians and engineers with documented experience in the design, assembly, programming, testing, installation, operation, calibration, troubleshooting, service and repair of control and communication systems for municipal systems and facilities.
 - 3. The System Integrator shall have completed the design, assembly, testing and installation of control systems which include the instruments and devices cited on the Plans by specific manufacturer's name.
 - 4. The System Integrator shall be experienced with the programming and commissioning of Allen Bradley PLC systems, operator interfaces, communications systems and VFD's.
 - 5. The System Integrator shall be an AVEVA registered System Integrator with experience in municipal SCADA system development and shall maintain the required development licenses to develop the project and provide future support

for the project. The System Integrator shall also be experienced with WIN-911 alarm software development.

6. The System Integrators manufacturing and testing facility shall be located within a 150 mile drive from the project location.
 7. The System Integrator shall be a UL508A listed and certified control panel manufacturing facility.
- C. The Contractor shall be responsible for the selection of the System Integrator. Integrators not listed below shall be subject to written approval by the Engineer prior to bid. Pre-approved System Integrators are:
1. Systems Interface Inc, Bothell WA.
 2. Quality Controls Corporation, Lynnwood WA.
 3. Technical Systems Inc, Lynnwood WA.
 4. Process Solutions Inc, Arlington, WA
 5. Taurus Controls, Kent, WA

1.05 DIVISION OF RESPONSIBILITY

- A. All materials and modifications to the existing control system shall be provided under the supervision of a single Contractor, which is regularly engaged in the design and installation of such systems of similar scope and complexity.
- B. The Contractor shall be fully and completely responsible for all work performed and all materials installed under the contract. The contract between the Contractor and subcontractor(s) shall conform to and meet all requirements specified in the contract documents.
- C. Electrical Contractor's Responsibilities:

The Electrical Contractor shall be responsible for the following:

1. Installation of all control system equipment in accordance with these documents, and drawings provided by the Control System Integrator.
2. Provide all electrical permits and inspections as required by the State of Washington.
3. Provide all connections to new and existing electrical equipment including MCC, VFD's, PLC's, instrumentation, control devices, packaged equipment, power generation equipment and other equipment as shown on the drawings.
4. Provide electrical panel modifications, demolition of existing equipment, raceway and other equipment and installation where required.

5. Coordination with the Owner for equipment installation, special operational needs for the facility, and facility scheduling requirements per 260500.1.016.
6. Provide temporary construction power and temporary equipment as listed in 260500.1.015.

D. System Integrator Responsibilities:

The System Integrator shall be responsible for the following:

1. Provide Motor Control Centers, VFD's, Control Panels, PLC and operator interface systems, instrumentation, communications, and control system equipment as shown on the drawings.
2. Provide complete SCADA computer system, per specifications.
3. Provide all software licenses and software development including all system programming including PLC's, instrumentation, VFD's, Operator Interfaces and SCADA system.
4. Provide complete system startup and commissioning, configure, program, test and commission the complete Control System and other process control equipment in coordination with Electrical Contractor, Owner and Engineer.
5. Provide additional system accessories as required for a complete and operational control system.
6. Provide system test forms to identify each test performed and document the completed testing procedures and sign off on operation with Owner and Engineer.
7. Provide final documentation, training, as-built drawings and Operation and Maintenance manuals.

E. Telecomm Contractor's Responsibility:

The Telecomm Contractor shall be responsible for the following equipment and services:

1. Selection of the networking system cabling, patch panels, patch cables, and other equipment as shown on the drawings, and as required for a complete and operational system.
2. Submittal of communications equipment hardware and topology diagrams for review by Engineer. Submittal shall be approved prior to ordering or installation of communications equipment.
3. Installation of communications system cabling, patch panels, patch cables, and other equipment.
4. Testing, certification and commissioning of the complete communications system.
5. Provide the copper cat 6 system cabling, color coordinated wall jacks and cabling and terminations from wall data jacks to data racks and panels.

6. Testing, certification and commissioning of the complete data communications system.

F. Equipment Supplier Responsibilities

The Equipment Supplier shall be responsible for the following:

1. Furnish all packaged equipment and installation requirements for Electrical Contractor installation.
2. Fully program, commission, adjust, test and put the new equipment into operation.
3. The Equipment Supplier shall address PLCs with IP addresses as specified by the Programmer.
4. The Equipment Supplier shall organize and allocate specific memory locations and PLC tags, as required, for complete monitoring of the equipment by the treatment facility PLC and SCADA system. These listings shall be coordinated with and provided to the Programmer prior to startup and commissioning.
5. The Equipment Supplier shall provide UL or ETL certifications for all equipment and equipment packages, as required by the State of Washington, L&I Electrical Inspection division. Field inspections for unlabeled equipment, including all costs and resulting project delays, shall be the complete responsibility of the Contractor.
6. All final programs shall be provided to the Owner with all passwords given to the owner to access and maintain the programs.

1.06 SUBMITTALS

A. Hardware Submittals

1. In addition to the requirements stated elsewhere in these documents, the following information shall be provided:
 - a. Before any components are fabricated, and/or integrated into assemblies, or shipped to the site, the System Integrator shall prepare a complete hardware submittal, including fully detailed shop drawings, catalog cuts, wiring connections, and such other documentation as may be required to fully describe the equipment and to demonstrate its conformity to these plans and specifications. Catalog information shall be submitted for all components and equipment required for the project.
 - b. All submittals shall be complete, organized, and indexed. Partial submittals will not be accepted.

B. System Drawing Submittals

1. Following approval of the Hardware Submittal, the System Integrator shall prepare complete system interconnect wiring diagrams and panel layout drawings for approval.

1.07 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance (O&M) data for the complete control system and related equipment, in accordance with the general requirements in Section 26 05 00.

PART 2 PRODUCTS

2.01 GENERAL

- A. Material shall be new, free from defects, and of the quality specified. All equipment and materials utilized in the system shall be the products of manufacturers with at least five (5) years experience in the manufacture of similar equipment. Similar items in the system shall be the products of the same manufacturer. All equipment shall be of industrial grade and shall be specifically intended for control, monitoring and operation of motor-driven pumps and equipment. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing.

2.02 MAJOR EQUIPMENT LIST

- A. The Contractor shall provide all of the equipment shown on the drawings, including but not limited to, the following major Control System equipment:
 - 1. Motor Control Center (MCC) with power distribution, motors controllers, VFDs, and other features as shown on the drawings.
 - 2. PLC control panels as shown on the drawings. Contractor shall provide detailed design drawings, bill of materials and data sheets for complete control system.
 - 3. Local and remote control panels, as shown on the drawings.
 - a. Main PLC Control Panel with Operator Interface
 - b. Influent Control Panel
 - c. Effluent Flow Meter Panel
 - d. Ventilation Control Panel
 - 4. Instrumentation as shown on the drawings, and specified herein:
 - a. Float Switches:
 - 1) Four floats at 2W pump station
 - 2) Four floats at Influent pump station
 - b. Level Transducers
 - 1) One transducer at Digester Basin

- 2) One transducer at Influent Pump Station
- c. Pressure Transducers
 - 1) One transducer for 2W pressure sensing
- d. Flow Meters
 - 1) INFLUENT FLOW METER. Size: 6". Install in vault with submersible kit. Transmitter located in influent control panel.
 - 2) TRAIN #1 FLOW METER. Size: 8". (future project - not in this project). Provide space for future transmitter in influent control panel.
 - 3) TRAIN #2 FLOW METER. Size: 8". Install in vault with submersible kit. Transmitter located in influent control panel.
 - 4) TRAIN #3 FLOW METER. Size: 8". Install in vault with submersible kit. Transmitter located in influent control panel.
 - 5) PLANT DRAIN FLOW METER. Size: 4". Install in vault with submersible kit. Transmitter located in influent control panel.
 - 6) EFFLUENT FLOW METER. Size: 8". Install in vault with submersible kit. Transmitter located in panel near UV basin. Provide NEMA 4X enclosure for transmitter.
 - 7) WAS FLOW METER. Size: 2". Install on piping near WAS pumps, mount transmitter to flow tube.
 - 8) 2W FLOW METER. Size: 1". Install on piping in hot box #1, mount transmitter to flow tube.
 - 9) Enclosures: Install flow meter transmitters as shown on the drawings. Provide enclosures as shown.
- e. Dissolved Oxygen (DO) Meters
 - 1) Two complete DO sensing systems, one in each Aeration zone of Treatment cell #3.
- f. H2S Sensor
 - 1) One sensor installed near new Dewatering equipment.
- g. Methane Sensor
 - 1) One sensor installed near new Dewatering equipment.
- h. Door Switch

- 1) One switch for Blower building main entrance.
- i. Smoke detector
 - 1) One heat/smoke detector in Blower building.
- j. Solenoid Valves
 - 1) Coordinate to provide solenoids for 2W and WAS control systems, per the drawings and specifications
- 5. Network equipment, cabling, accessories, and testing.
 - a. Network switches in Main Control Panel, Motor Control Center, Influent Control Panel and at SCADA operator station in Lab.
- 6. SCADA system hardware and software, as specified.
- 7. Installation of all packaged equipment system panels, equipment, and instrumentation per manufacturer drawings.
- 8. Programming and commissioning of all PLC, operator interface and SCADA systems.

2.03 CONTROL PANELS

- A. Control panels shall be designed, assembled, programmed, tested and placed into operation by the System Integrator with support from the Electrical Contractor.
- B. The control panel shall fit into the space requirements as shown on the drawings. The contract drawings show general control panel layout and space requirements. Final dimensions shall be selected by the System Integrator to adequately install and wire the required control equipment.
- C. Detailed panel layout and interconnecting drawings shall be submitted prior to ordering of materials, and shall be subject to review and approval by the Engineer.
- D. Material shall be new, free from defects, and of the quality specified. Similar items in the system shall be the products of the same Manufacturer. All equipment shall be of industrial grade and of standard construction, shall be capable of long, reliable, trouble-free service, and shall be specifically intended for control and monitoring industrial equipment.
 - 1. Indoor Control Panels
 - a. Cabinet shall be a NEMA 12 enclosure, with back panel. Cabinet shall be fabricated from 16 ga. minimum thickness sheet steel, and shall be ANSI 61 gray standard phosphate finish. Panel interiors and back panels shall be white. Cabinet shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Three-point latch hardware shall be provided for doors exceeding 30 inches high. Hoffman Concept series, or equal.

- b. The panel shall include padlocking quick release L-handles to allow the panel to be opened without the use of tools. Hoffman, Hammond, or equal.

2. Outdoor Control Panels

- a. Cabinet shall comply with NEMA 4X requirements as shown on the drawings and to meet the control equipment manufacturers' environmental requirements. The panel shall be fabricated from Type 316 Stainless Steel, and shall include a hidden hinge and back panel for equipment mounting. Hoffman, Hammond, or equal.
- b. Panels that are mounted outdoors shall be provided with a sun shield, or with a ventilation/cooling system to maintain the internal temperature of the panel interior within the equipment ratings at typical ambient temperatures for the installation conditions. Drip shields shall be installed to prevent water buildup on top of panel doors. Panel fans and/or ventilation systems shall be thermostatically controlled.
- c. The panel shall include thru the door main disconnect and padlocking quick release L-handles to allow the panel to be opened without the use of tools. Hoffman #ELHP, or equal.

E. Operating and Indicating Devices

- 1. Operating and indicating devices minimum rating shall be NEMA 13. Operator devices mounted in outdoor panels, corrosive areas or where exposed to moisture shall be NEMA 4X.
- 2. Selector Switches
 - a. Selector switches shall be for use on 120 volt control circuits. Contacts shall have a continuous current rating of 10 amperes both inductive and resistive. Selector switches shall be of the heavy duty oil tight type. Allen Bradley, Bulletin 800T, 800H, or equal.
- 3. Push buttons
 - a. Push buttons and illuminated push buttons shall be for use on 120 volt and 24 VDC control circuits and shall have continuous current rating of 10 amperes both inductive and resistive. Pushbuttons for "E-STOP" or emergency applications shall have maintained contacts and red mushroom head operators. Allen Bradley, Bulletin 800T, 800H, or equal.
- 4. Indicating Lights
 - a. Indicating lights shall be push-to-test oil tight type. Units shall have LED lamps and shall be of the illuminated pushbutton type with the pushbutton wired for the push-to-test function required. Appropriate LED and lens color shall be provided as shown. Allen Bradley, Bulletin 800T, 800H, or equal.

5. Analog Indicator
 - a. Indicator shall have LED process display with 68 x 33 mm minimum dimensions and 0.48" backlit display to indicate wet well level. 24 VDC powered. 4-20 mA process input.
 - b. Resolution shall be displayed to one tenth of one foot XX.X ft.
 - c. Display shall be Red Lion CUB 4 series, or Engineer approved equal.
6. Control Relays
 - a. Relays for general purpose use shall be DPDT, 5 ampere minimum contacts with the appropriate coil voltage for the application. They shall have an 8-pin base, matching socket, and contact status indicator. All relays shall include MOV snubbers (for AC) or diodes (for DC) applied across the relay coils to reduce the surge caused by coil breakdown transients. Relays shall be Idec RH2B-ULD, or equal.
7. Terminal Blocks
 - a. Terminal blocks shall be 600 volt modular terminal blocks with tubular screw and pressure plate. Provide a minimum of 20% or four whichever is greater, spare terminals in each panel. Allen-Bradley #1492-J3 series, or equal.
8. Seal Fail and Thermal Relays
 - a. Pump seal fail and thermal relays shall be installed for each submersible pump in the system, where required by the pump manufacturer. The relay shall be capable of connecting to a seal failure probe and thermal contacts in the pump housing, and shall have output contacts to energize external indicator lights.
 - b. It is the responsibility of the pump control panel manufacturer to select and install the relays with the pump equipment provider for compatibility.
 - c. Relays shall be Mini-CAS, or engineer and manufacturer approved equal.

2.04 INSTRUMENTATION

A. Float Switch

1. Switch shall be free floating, direct acting float switch designed for operation in raw sewage.
2. Mounting hardware shall include fixed installation on a 1" pipe, or suspended with a Kellems cord grip/strain relief and a weighted stainless steel support cable.
3. The float cable shall be a PVC coated multicore connecting cable which also contains the conductors, and shall be UL listed.

4. Float shall contain a non-mercury switch with a minimum rating of 4 amps at 120 Volts.
5. Float shall be foam-filled, hermetically sealed and polypropylene coated.
6. Floats shall be supplied with cable of sufficient length to reach the junction box without splices.
7. Intermediate relays and intrinsic safety barriers shall be provided for all wet well instrumentation in accordance with NFPA 820 and NEC article 500 for Class I, Div 1&2 areas.
8. Level switches shall be Orenco, MF series or Anchor Scientific Inc. 'Eco-Float' Model G. Include cable mounting kit and/or float stem and all required accessories, or equal.

B. Submersible Level Transducer for Waste Water applications

1. The level sensor shall be a submersible pressure transducer with flush diaphragm designed for raw waste water and slurry applications.
2. It shall utilize a piezoresistive silicon strain gauge transduction principle with an accuracy of +/- 0.25%. The sensor housing and internal components shall be titanium, and the diaphragm shall be Teflon coated rubber.
3. The sensor shall be selected to provide sensing over the full range of levels in the wet well for the application.
4. The sensor shall include a PVC support structure, stainless steel mounting hardware, and all manufacturer recommended hardware for mounting in the wet well.
5. The sensor shall be FM approved for installation in Class I, Div 1 Hazardous areas, and shall include an Intrinsic Safety Barrier in the Pump Control Panel, and include a 2-wire 4-20ma output compatible with 9-32Vdc excitation.
6. Provide manufacturer dessicant system for vent tube to prevent moisture buildup in the transducer vent line.
7. Level Sensor shall be KPSI Esterline model 750 for raw wastewater, or Engineer approved equal.

C. Pressure Transducer

1. Pressure Transducers shall be of the piezo-resistive bridge design, intended for the purpose of measuring water pressure. The bonded resistance shall provide a linear response proportional to the pressure. The accuracy of the transducer shall be within 0.25% of full scale. Transducer housing and sensor shall be constructed of 316 stainless steel. The transducer shall secure its power from the current loop supply. The system shall be operate on a supply rated from 10-36 VDC, and have a power consumption of no more than 20 watts each.

2. Each transducer shall be wet-calibrated at the manufacturer's facility against the master system. A calibration certificate shall be furnished for each transducer.
3. Pipe mounting hardware, isolation valves, and other manufacturer recommended options shall be included.
4. Pressure ranges shall be coordinated with the pump supplier and submitted for Engineer review.
5. Pressure transducers shall be ASCO Model G2, G27M0242E0200##+CavG, or Engineer approved equal.

D. Electromagnetic Flow Meter

1. Provide and install the magnetic flow meters as shown on the Contract Drawings and specified herein. The flow meters shall be complete with all necessary accessories and hardware for a complete and workable installation.
2. Flow meters shall be for measurement of raw liquid wastewater and sludge.
3. General: The magnetic flow meters shall be of the low frequency and short form coil design. The field principle of electromagnetic induction shall produce a positive DC pulsed signal directly and linearly proportional to the liquid flow rate. The metering tube shall be constructed of carbon steel with ANSI flanged end connections. Electrodes can either be protruding (bullet nose), but shall be of 316 stainless steel construction. The material of construction of the liner shall be hard rubber. The meter shall secure its power from the signal converter. No electronics shall be mounted in the metering tube of the magnetic flow meter.
4. The signal converters shall be integral to the flow head for indoor installations. Signal converters shall be remote mount for meters installed in vaults or where subject to submergence. The flow meter shall be capable of accidental submergence to 30 feet for a period of 24 hours.
5. The signal converters shall convert the output signal from the flow meters into a 4-20 mA signal directly proportional to flow rate. The signal converters shall have automatic zero correction. The accuracy shall be ± 0.5 percent of the actual flow rate. The signal converters shall transmit an isolated analog 4-20 mA D-C signal, directly proportional to flow and a totalizer contact for remote flow totalization. The signal converters shall be designed to operate from a 120 ac, 60 Hz, single phase, power source, or 24VDC as shown on the drawings. The signal converters shall generate power for the magmeter.
6. The magnetic flow meter enclosure shall be NEMA 4X classified, and rated for Class I, Div.2 installation. The units shall be labeled and listed by a recognized electrical testing laboratory for the application, or Approved by the Washington State Department of Labor and Industries for installation on the Project.
7. Each meter system shall be wet-calibrated at the manufacturer's facility against the master system. A calibration certificate shall be furnished for each meter.

8. Type 316 Stainless Steel grounding rings shall be provided, on both sides of the flow meter, per manufacturer's recommendations. Grounding rings shall be provided on both non-metallic and cement lined piping. The Contractor is fully responsible for providing the appropriate grounding rings for the fittings attached to the flow meter. Confirm required materials with manufacturer(s) and submit detailed grounding ring information showing compatibility with flow meter flanges and pipe fittings used for each flow meter location.
9. Flow meter quantities and sizes shall be per the Civil Engineering sheets and corresponding pipe sizes.
10. The magnetic flow meters and signal converters shall be Endress-Hauser, Proline Promag L400 series, with Ethernet communications.

E. Dissolved Oxygen Monitoring system

1. Provide complete Dissolved Oxygen (DO) monitoring systems to be installed in the treatment cell aeration zones. Qty: 2 systems per cell.
2. Probe: Hach LDO series 0-20 PPM range, 10 meter cable with quick disconnect plug
3. Controller: Hach SC200 controller, 0-20 PPM range, 4-20 mA output, 24VDC power.
4. Pole mount kit with service bracket and all required accessories for installation on treatment cell handrail.

F. Hydrogen Sulfide Sensor

1. Hydrogen Sulfide Sensors shall be of the Electrochemical type with a range of 0-100 PPM, accuracy of +/- 1 PPM and a resolution of 0.1 PPM. 120VAC power.
2. Sensor housing shall be 316 stainless steel and rated for the environment it is to be installed in.
3. Hydrogen Sulfide Sensors shall be Sierra Monitor Corporation Model #5100-05-IT, or Engineer approved equal.

G. Combustible Gas Detector (for Methane detection)

1. Combustible Gas Sensors shall provide a range of 0-100 % lower explosive limit (LEL). Alarm Limit = 10% LEL. 120VAC power.
2. Sensor housing shall be 316 stainless steel and rated for the environment it is to be installed in.
3. Combustible Gas Sensors shall be Detcon Model FP-524D, or Engineer approved equal.

H. Smoke Detector

1. Combination smoke and heat detector.
 2. System sensor model #4WTAR-B with form C relay, sounder, 4 wire, or approved equal.
- I. Door Switch
1. Provide door switch for intrusion sensing.
 2. Magnetic reed style, SPDT.
 3. Interlogix Sentrol Model 2807T, or approved equal.

2.05 PROGRAMMABLE LOGIC CONTROLLER AND SUPPORT COMPONENTS

A. PLC hardware

1. A complete PLC and communication system shall be provided with the logic and communications capabilities as shown on the drawings and in these specifications.
2. All PLC hardware shall be manufactured by Allen Bradley, no exceptions.
3. General selection as specified herein. Specific quantities and additional requirements as determined by System Integrator.
4. PLC Platforms:
 - a. CompactLogix:
 - 1) Processor: Model 1769-L33ER
 - 2) Communications: Integral Dual port Ethernet/IP
 - b. Power supply: 1769 series, sized to accommodate all hardware.
 - c. Hardware Chassis: Integral
 - d. Input and Output cards: 1769 series for analog and discrete inputs and outputs. Point count to include a minimum of 20% spare for each card type used.
5. Power Monitors
 - a. Allen Bradley Power Monitor 5000.

B. Programming of PLC and Operator Interface

1. The System Integrator shall provide all programming and functional testing for the entire control system according to the descriptions in this specification and features shown on the drawings and place the complete system into operation.

2. The specifications indicate minimum system requirements. The programmer shall provide all required programming for a complete and functional control system.
3. Field adjustments or additional features added during startup and commissioning shall be included in the bid price.
4. The Contractor shall provide field technicians to assist with the startup and functional checkout of the complete PLC and control system.
5. All final programs shall become the property of the owner and shall be provided on USB drive with full access rights.

C. Operator Interface Unit (OIU):

1. One operator interface unit shall be provided for the Main PLC control panel in the Blower building.
2. The operator interface unit(s) shall be a 9 inch wide aspect color touch panel with Ethernet communications and 24VDC powered.
3. Operator interface shall run Windows CE Pro operating system and shall provide for real time monitoring of the terminal displays from a web browser.
4. Provide all required cables and pre-loaded development software and licenses for a complete and operational system.
5. System Integrator shall program, test and commission the OIU in accordance with these specifications.
6. Manufacturer: Allen-Bradley Panelview Plus 7 performance terminal, #2711P-T9W22D9P, or latest approved model at the time of submittal.

D. Network switches

1. Provide network switches as required for the connection of all Ethernet enabled devices.
2. Provide switches in control panels, MCCs, and other areas as required for a complete Ethernet communication system.
3. Switches shall be Allen Bradley Stratix 5700, 8 or 16 x 10/100 Mbps copper ports, 2 or 4x 10/100/1000 Mbps, DLR, 24-48VDC. Port quantities as required.
4. Network shall be wired in a Ring configuration to provide network redundancy.

E. DC Uninterruptible Power Supply (UPS)

1. DC UPS systems shall be provided for all PLC control panels.
2. A complete DC UPS system shall be supplied for each control panel as shown on the drawings, and shall be manufactured by Allen Bradley.

3. DC systems shall include DC power supply, Allen Bradley 1606-XLE240EN with 1606-XLS240-UPS and 1606-XLSBATASSY2 26 Ah battery assembly. Include all required mounting brackets and accessories.

F. AC Power Line Filter

1. Provide Active Tracking Line Filter in each control panel with 120 VAC input.
2. Manufacturer: Islatrol model IE-120, or Engineer approved equal.

G. PLC Programming Software

1. PLC and OIU programming software shall be provided by the System Integrator for use in developing the software applications for the project, and shall be a current and registered Rockwell Automation programmer with software development licenses and support.
2. Electronic copies of all final PLC and OIU programs will be provided to the Owner at the completion of the project with full ownership rights and all password protection removed or registered to the Owner.
3. The System Integrator may offer the Owner ongoing future technical support following final commissioning of the project, and shall be subject to Owners approval. The Owner shall, at any time after final commissioning, have the ability to hire another registered Rockwell Automation registered integrator to support or modify the existing programs.

2.01 SCADA COMPUTER SYSTEM AND EQUIPMENT

A. A complete SCADA computer system shall be provided by the Contractor. Computers shall be Dell or equal, with the following minimum requirements:

1. Intel Core i9, 16M Cache, 8 core, 5.2 GHz or latest premium processor
2. NVIDIA GE Force, 12 GB GDDR6 or equal
3. (2) 8 GB DDR3 SDRAM 1600 MHz, 2 DIMMs
4. 2 TB SSHD
5. 16x CD/DVD burner drive
6. Energy efficient power supply
7. Ethernet network adapter, gigabit
8. 27" UHD flat panel display DVI with sound bar
9. Wireless optical mouse and Wireless keyboard
10. 750VA UPS w/surge protection and power strip

11. Local 8 port desktop network switch
12. Short throw projector (to project SCADA screen on wall): Epson Ultra LS300 or equal.
13. Windows 10 Professional operating system, 64 bit
14. Windows Office Professional, latest edition
15. 3 year hardware warranty

B. SCADA Software and Licensing

1. The SCADA software shall be AVEVA (previously Wonderware) and provided by the System Integrator through Industrial Software Solutions, Bothell WA. The local representative is Rick Loya, Sr. Account Development Manager, 425.829.9420.
2. The System Integrator shall be an AVEVA registered Integrator, Certified Integrator preferred.
3. The System Integrator shall maintain all licensing and certification for AVEVA development capacity, including Development Studio.
4. All AVEVA licensing for the SCADA system shall be based on the Annual Subscription model. Software shall be registered in the name of the Owner. The System Integrator shall provide a 3-year subscription for the Owner for all AVEVA software, and the term shall begin when the system is fully tested and commissioned and handed over to the Owner. The Owner shall be responsible for future Annual support beginning at the end of the 3 year term.
5. SCADA software shall include:
 - a. AVEVA InTouch Runtime 500 Tag with I/O
 - 1) Provided for local visualization, monitoring and control
 - 2) Includes AVEVA communications drivers
 - 3) Includes AVEVA Customer First technical software support
 - 4) Includes 3 year annual licensing subscription
 - b. AVEVA Insight Standard with 1 Year History
 - 1) Provided for Cloud-based historical data monitoring and reporting tools.
 - 2) 10,000 data points at 5 second data rate
 - 3) 2 Standard Users included

- 4) 1 Additional Standard User Provided, 3 total users
- 5) Includes AVEVA Customer First technical software support
- 6) Includes 3 year annual licensing subscription

c. WIN 911 Interactive Alarm Monitoring Software

- 1) 2 way communication with all notifiers: SMS, email, Voice, and 10 smartphone apps
- 2) Includes WIN-911 Customer Care technical software support for first year

C. Alarm Monitoring Software and Licensing

1. The alarm monitoring software shall be WIN-911 Mobile.
2. The alarm software shall reside on the SCADA computer and use the Internet connection to send alarms. The web notifications are encrypted with HTTPS and all connections are outbound initiated, so WIN 911 Mobile is deployed without opening a port on the firewall or introducing threats to the local network. Each operator can run the app on their smartphone and it is compatible with both IOS and Android devices.
3. The alarm software licensing shall be a 1 year perpetual license provided by the System Integrator. Software shall be registered in the name of the Owner. The term shall begin when the system is fully tested and commissioned and handed over to the Owner. The Owner shall be responsible for annual WIN-911 support if required, beginning at the end of the first year after commissioning.
4. Key features of the WIN 911 Mobile software shall include:
 - a. Configurable Push Notifications:
 - 1) Ringtone selection
 - 2) Alert operator to alarm, report, and chat activity
 - 3) Acknowledge alarm with single click
 - 4) Supports smartwatch notification
 - b. Instant Insight into Alarms:
 - 1) See alarm changes in real time
 - 2) Current alarm states on single screen
 - 3) Multi-selectable alarm acknowledgements
 - c. Alarm Details:

- 1) Gives up to date alarm details and history
 - 2) Configurable properties from within the app
 - 3) Acknowledge alarms with comments
- d. Collaborative chat:
- 1) Gives operators an easy way to collaborate, comment, and resolve problems faster
 - 2) Each alarm instance has its own chat room
- e. Reports:
- 1) Provides the details needed to make informed decisions
 - 2) Display real time process values and alarm states
 - 3) Reports automatically sync with WIN 911
 - 4) Push reports on specific alarm conditions
- f. Team Visibility:
- 1) Displays who has and has not seen the alarm
 - 2) Shows who has been sent the alarm
 - 3) Shows who is in 'do not disturb' mode

2.02 SPARE PARTS

- A. In addition to spare parts mentioned elsewhere in this section, the Contractor shall supply the following spare parts:
1. 4 Spare LED indicators and one cap of each color used for indicating lights.
 2. One spare control, time delay, phase fail, seal fail, etc. relay of each type used, or 20% whichever is the greater number.
 3. Two spare fuses for each fuse provided under 10 amperes and one spare fuse for each fuse provided over 10 amperes.

PART 3 EXECUTION

3.01 GENERAL

- A. Install materials and equipment in a workman-like manner utilizing craftsmen skilled in the particular trade. Provide work which has a neat and finished appearance.

- B. Coordinate Instrumentation and Control work with the Contractor, Owner, and work of other trades to avoid conflicts, errors, delays and unnecessary interference with system operations during construction.

3.02 COORDINATION WITH CONTRACTOR

- A. The System Integrator shall coordinate directly with the Contractor to ensure all requirements within the scope of this Section are satisfied.

3.03 SYSTEM SIMULATION

- A. To the degree possible, the entire control system shall be simulated at the Contractor's facility prior to commissioning.
- B. The Engineer, Contractor and Owner personnel shall be invited to witness simulation and approve test results prior to shipment to Contractor.

3.04 FIELD ACCEPTANCE TEST

- A. The System Integrator shall conduct acceptance tests and provide operator training for the complete and functional control system.

3.05 PROTECTION DURING CONSTRUCTION

- A. The Contractor shall provide protection for materials and equipment against loss or damage and the effects of weather.
- B. Prior to installation, store items in an indoor, dry location. Provide heating in storage areas for items subject to corrosion under damp conditions.
- C. Specific storage requirements shall be in accordance with the manufacturer's recommendations.

3.06 MATERIAL AND EQUIPMENT INSTALLATION

- A. Follow manufacturer's installation requirements, unless otherwise indicated. Wherever any conflict arises between manufacturer's instructions and these Contract Documents, follow Engineer's decision, at no additional cost to the Owner. Maintain a copy of manufacturer's installation instructions on the jobsite at all times.

3.07 INSTRUMENTATION INSTALLATION

- A. Process Connections
 - 1. Unless otherwise specified, process taps shall comply with API RP550. Root valves shall be provided at taps, except temperature taps and pump discharge pressure taps. Process connections shall be arranged, where possible, such that instruments may be readily removed for maintenance without disruption of process units or draining of large tanks or vessels. Unions or flange connections shall be provided as necessary to permit removal without rotating equipment. Where process taps are not readily accessible from instrument locations, a block valve

shall be provided at the instrument. Block valves shall also be provided for each instrument where multiple instruments are connected to one process tap.

- B. Electrical Connections
 - 1. Final connections between rigid raceway systems and instruments shall be made with jacketed flexible conduit with a maximum length of two feet.
- C. Identification
 - 1. Tagging
 - a. All field instruments shall be labeled with function and instrument number, i.e. (FIT-301/EFFLUENT FLOW METER). Tag shall be 10ga 316 stainless steel with stamped letters and numbers attached to device with 12ga 316 stainless steel wire.

3.08 CONTROL SYSTEM PROGRAMMING, STARTUP AND TESTING

- A. The Control Panel Manufacturer shall provide all programming and functional testing for the PLC and control system and place the complete system into operation.
- B. The Control System shall be programmed and operate according to the descriptions in this specification and features shown on the drawings. This description indicates minimum system requirements. The Control Panel Manufacturer shall provide all required coordination for a complete and functional control system. Field adjustments or additional features added during startup and commissioning shall be included in the bid price.
- C. The control system shall be put into operation by the System Integrator with support of the Electrical Contractor.
- D. A witnessed Functional Acceptance Test shall be performed on the completed control system.
 - 1. The System Integrators standard test forms shall be submitted for review by the Engineer, including complete test procedure and forms.
 - 2. Each feature and function of the control system shall be documented on the test forms and shall be tested and demonstrated to the satisfaction of the Engineer. The System Integrator shall make all revisions to the control system operation noted by the Engineer prior to final acceptance.
 - 3. The testing program shall be conducted in accordance with the prior approved procedures and shall be witnessed and signed off by both the System Integrator and the Engineer upon satisfactory completion.
- E. All special testing materials and equipment required to demonstrate compliance with the specification shall be provided by under the scope of this Section. Where it is not practical to test with real process variables, provide suitable means of simulation. These simulation techniques shall be subject to the approval of the Engineer.

- F. Coordinate all testing with other associated suppliers and subcontractors.
- G. All final software programs shall become the property of the Owner and shall be provided on USB flash drive with full access rights.

3.09 DESCRIPTION OF OPERATION

The following descriptions describe the general requirements for the Control System functional operation. The PLC, Operator Interface and SCADA system shall be programmed by the System Integrator to provide the monitoring and control for the functions described herein.

Additional detail shall be provided to the Programmer by the Engineer during software development to provide a complete and operational Control System which operates to the intent of the drawings and specifications.

A. WAS Valves and WAS Pump Control:

1. There are two WAS pumps controlled from the MCC with VFD's. Select Primary WAS pump and Backup WAS pump on the OIU or SCADA screen. Primary pump shall operate unless there is a pump failure, where the Backup pump will move into the Primary position.
2. There are three 2" Normally Closed WAS solenoid valves, one for each Train (#1, #2, and #3). The valves operate as full open/full close. Configure controls to open valve X times per day, and run WAS pumps for Y minutes during each open cycle, as set on the OIU or SCADA screen.
3. Confirm WAS flow meter measures flow while pump is running. If there is no flow, generate an alarm and shut down pump. After programmed duration has passed, turn off WAS pump and confirm flow meter measures "no flow". Then close WAS valve.
4. Display total volume wasted each day (gpd) on the OIU or SCADA screen. Normal operation will waste somewhere between 2,000 and 8,000 gallons total (each day), based on operator's preference.
5. Each WAS pump can pump between 10 and 30 gpm. Manually adjust to desired pump speed. Initial set point = 20 gpm. VFD speed in HAND will be set on potentiometer on MCC panel; VFD speed in AUTO will be as set on the OIU or SCADA screen.
6. Offset wasting per Train by open duration so wasting doesn't overlap. i.e. waste from Train #1 for 6 minutes, then Train #2 for 6 minutes, then Train #3 for 6 minutes.
7. WAS valves shall be Normally Closed (Fail Closed).

B. Train #3 Biological Treatment System:

1. A complete biological treatment system, including aeration, mixing, clarifier, blowers, and instrumentation.

2. The complete treatment control panel shall be provided by the Biological Treatment System vendor, and shall be hard-wired controls. Provide monitoring via dry contacts of treatment system panel and display on the OIU and SCADA screen. Program alarms for treatment panel alarm points.
3. There are four 20 HP blowers that will operate to aerate the treatment basins. One aerator for each Train. Fourth blower is redundant backup in case primary blower fails.
4. Program aeration routine to monitor DO levels in each basin and adjust Blower speed based on PID algorithm for automatic aeration control.
5. For each blower, VFD speed in HAND will be set on potentiometer on MCC panel; VFD speed in AUTO will be as determined by the PLC based on the setpoint on the OIU or SCADA screen.
6. A similar system will be added for Train #1 and #2 in Phase 2. Allocate spares in hardware and software systems for future systems.
7. See section 46 53 00 – Biological Treatment System.
8. See section 43 11 00 – Blower Equipment.

C. Carbon Feed to Individual Trains:

1. One peristaltic metering pump.
2. Provide 4-20 mA output from PLC to each metering pump for flow pacing. Output based on set point at the OIU or SCADA system.
3. Set point to be manually adjusted, based on Operator preference. See section 46 53 00 – Biological Treatment System.

D. Influent and Effluent Samplers:

1. Owner-provided samplers require flow pace input.
2. Provide 4-20 mA output from PLC to each sampler.
3. Influent sampler flow pace to match WWTP Influent flow meter.
4. Effluent sampler flow pace to match WWTP Effluent flow meter.

E. UV Disinfection system:

1. There are two UV disinfection units required for the project.
2. Each UV system shall be furnished with a system control panel by the manufacturer. All UV control shall be from the system controllers.
3. A dry contact shall be wired from the UV panel to the PLC control panel for “system status”.

4. An analog output from the UV panel shall be wired to the PLC control panel for “Intensity level”.
 5. See section 46 66 00 – UV Disinfection System.
- F. Aerobic Digester:
1. Level Monitoring: One submersible transducer shall monitoring digester water level and display on the OIU and SCADA screens.
 2. Blower: One 5 HP blower, controlled from VFD in MCC.
 3. Manually adjust to desired pump speed. VFD speed in HAND will be set on potentiometer on MCC panel; VFD speed in AUTO will be as set on the OIU or SCADA screen.
 4. See section 43 11 00 – Blower Equipment.
- G. Rotary Fan Press System:
1. A complete dewatering system per specifications.
 2. System includes the following:
 - a. Rotary Fan Press (1.5 HP), Air Compressor (3 HP), Flocculator (1 HP), & Controls. See Section 46 76 26 – Rotary Fan Press
 - b. Screw Conveyor System. See section 41 12 13 – Screw Conveyor System.
 - c. Emulsion Polymer Make Up Water System. See section 46 33 33 – Emulsion Polymer System
 3. Dewatering system shall include Allen Bradley 1769 series Compact Logix PLC for control of the dewatering system. Vendor shall provide network connection to WWTP SCADA system for remote monitoring and setpoint control.
 4. Control parameters over Ethernet shall be coordinated between the dewatering system programmer and System Integrator for monitoring and control requirements.
 5. Output from the Dewatering PLC System will provide control speed of the Digested Sludge Pump VFD in the MCC to maintain sludge plug pressure.
 6. Dewatering control system shall monitor the water level in the Aerobic Digester, and turn “off” at low set point. Coordinate set points for the OIU and SCADA screens.
- H. 2W Plant Water System:
1. There are two 5 HP 2W pumps controlled from VFDs in the MCC.

2. Design flow range = 0 to 80 gpm. Maintain a constant pressure based on the pressure feedback signal to the PLC, based on pressure setpoint on the OIU and SCADA screens.
3. Initial set point between 60 and 70 psi. Control logic is to turn pump(s) on, adjust speed via PID algorithm, turn pump(s) off, as needed to maintain pressure set point.
4. See section 43 22 10 – 2W Plant Water System.

I. Water Supply to 2W Air Gap:

1. Domestic water feed to two hot boxes, just west of the 2W Plant Water Wet Well.
2. System includes a solenoid valve, 1” flow meter, and an air gap assembly.
3. Program the PLC to operate the solenoid valve to open and close based on 2W wet well water level (float control).
4. See section 43 22 10 – 2W Plant Water System.

J. Ventilation Control Panel

1. Ventilation fans shall be provided in the treatment building to de-classify the dewatering area during dewatering system operation.
2. A ventilation control panel shall be provided for HOA operation of each of (3) wall fans and visual and audible alarm notification.
3. In HAND, the fan operation will be manually controlled. In AUTO, the fans will all turn on together (with 2 second time delay between fans for starting). A signal from the dewatering PLC will be sent to the WWTP PLC to indicate dewatering system operation and turn on the building ventilation fans. The fans will operate continuously while the dewatering system is in operation.
4. Hydrogen Sulfide Sensor: The 4-20 mA signal from the sensor will monitor the gas levels in the dewatering room. If the level reaches the setpoint alarm level as set on the OIU and SCADA screens, activate the alarm light and horn and an alarm on the SCADA system. If the fan selector is in AUTO, activate the fans.
5. Combustible gas detector: The 4-20 mA signal from the sensor will monitor the gas levels in the dewatering room. If the level reaches the setpoint alarm level as set on the OIU and SCADA screens, activate the alarm light and horn and an alarm on the SCADA system. If the fan selector is in AUTO, activate the fans.

K. Generator, ATS and Power Monitor:

1. Status signals shall be wired from the new diesel Generator and ATS to the PLC.
2. Provide indication on the OIU and SCADA screens for Generator Running and alarm status.

3. Provide indication on the OIU and SCADA screens for ATS Normal Power and Emergency position status.
 4. Data from MCC power monitor shall be polled by the PLC over Ethernet and displayed on the OIU and SCADA screens. Display critical power data including current, voltage, KW, power factor, etc.
- L. Intrusion Monitoring:
1. Intrusion logic shall be programmed in the PLC to generate individual alarms for the blower room door. The alarms shall be enabled/disabled at the local operator interface (OIU).
- M. Smoke and Heat Alarm Monitoring:
1. Provide status and alarm monitoring for smoke detector in the Blower building. Provide indication on the OIU and SCADA screens
- N. Influent Pump Station:
1. The Influent pump station shall include Two Small Pumps (3 HP each) and Two Large Pumps (5 HP each). The starters shall be FVNR and located in the Influent pump station control panel.
 2. A PLC system shall be provided as a remote rack to allow control and monitoring from the Main PLC controller.
 3. Primary control of the four pump station pumps shall be by the PLC via setpoints as measured by the wet well level transducer. Set points are shown on sheet E4.2, and shall be adjustable from the OIU and SCADA system.
 4. Each motor control circuit shall have a local Hand-Off-Auto control switch, mounted to the control panel. When in AUTO, the pump shall be enabled for Automatic control by the PLC control system. When in HAND mode, the pump shall run until switched to OFF.
 5. The level transducer shall be monitored for a valid signal. If the signal fails, an alarm will be activated, and the float back up system will operate the pumps.
 6. A high level float switch for each pump and hard wired circuit shall be provided for redundant pump control, as shown on the drawings. If the high level float switch activates, the associated pump shall be called to run for the amount of time as set on the time delay relay.
 7. Seal Fail and overtemperature sensors shall be wired to the control panel. Local alarm and status indicators shall be provided on the control panel and monitored on the OIU and SCADA system.
 8. A step down transformer and load center shall be installed for local 120V control panel as shown in the panel schedules.

9. Provide Intrinsically Safe area and barriers as required to meet Code for Classified locations, as indicated on the drawings.
10. Provisions and space shall be provided for the flow meter transmitters as shown on Sheet E8.1.

O. Main PLC control panel:

1. The Main PLC controller shall be located in the Blower building in a new NEMA 12 control enclosure. Provide all required PLC and I/O as indicated on the drawings. Provide all power distribution, terminals, overcurrent protection etc as required for a complete and operations system. The System Integrator shall provide final documentation, design and selection of components based on the functional requirements shown on the design drawings and specifications.
2. The Main PLC controller shall be programmed by the System Integrator to monitor the complete treatment system, pump station performance, MCC equipment, aeration system, wet well levels, treatment system status, instrumentation, equipment run times, equipment faults, and all related monitoring and control.
3. Main PLC Panel Operator Interface Unit (OIU):

The operator interface shall be programmed with the following minimum features:

- a. System overview screen showing system overview, pump status, wet well level, switch status, and all other available process information.
- b. Alarm screen with each alarm configured with detailed description and time and date stamp.
- c. Trending screen to display graphs of process data including wet well level, pump cycles and other relative information.
- d. Maintenance screen showing equipment run times and start counts.
- e. Intrusion monitoring and control.
- f. Set point screen to allow password-protected system set point changes for all control and alarm points.

3.010 Supervisor Control and Data Acquisition (SCADA) System:

A. SCADA System Software

1. The System Integrator shall develop the custom graphical for the SCADA computer application based on this specification and input from the Owner and Engineer.
2. The functions and screens shall utilize the full software capabilities of the software provided.

3. The SCADA screens shall be developed in coordination with the operator interface screens at the Blower room, for a similar look and operation between the operator interface and new SCADA computer.
4. The proposed SCADA screens will include, but not limited to:
 - a. System Overview: Plan view of the Wastewater Treatment Facility showing key process data and operational status of each motor (running/stopped/failure), instantaneous flow rate for each flow meter, total influent and effluent flow, levels, DO and other critical process data. This screen provides a large-scale overview of the entire treatment system.
 - b. Blower System and Aeration Screen: Provide a detailed graphical screen with all equipment and process information including Blower system, VFD status and speeds, DO measurements, DO control setpoints, alarm setpoints, level, temperature, flow, pump starts, pump runtime, and alarm setpoints.
 - c. Train #3: Provide a detailed graphical screen with all equipment and process information including Treatment system, mixers and scraper arm motor status, DO measurements, DO control setpoints, alarm setpoints, skimmer system, torque limit status, pump starts, pump runtime, and alarm setpoints. Provide provisions for future Trains #2 and #1.
 - d. UV Disinfection and Aerobic Digester: Provide a detailed graphical screen with all equipment and process information including UV system status, flash mixer motor status and control, Digester Level measurement, level alarm setpoints, pump starts, pump runtime, and alarm setpoints.
 - e. WAS Screen: Provide a detailed graphical screen with all equipment and process information including WAS system, VFD status and speeds, WAS flow rate and totals, WAS valve control setpoints, alarm setpoints, pump starts, pump runtime, and alarm setpoints.
 - f. 2W Water System Screen: Provide a detailed graphical screen with all equipment and process information including 2W pumping system, float status, VFD status and speeds, 2W flow rate and totals, 2W system pressure, 2W valve control setpoints, alarm setpoints, pump starts, pump runtime, and alarm setpoints.
 - g. Influent Pump Station Elevation: Shows the water elevation of the wet well as measured by the submersible level transducer, float switch status, and pump status (running/stopped/failure). Indicate control set point levels and set point control.
 - h. Dewatering Screen: Provide a detailed graphical screen with all equipment and process information from the Dewatering PLC panel. Include VFD status and speed for the sludge pump, control setpoints, alarm setpoints, Dewatering flow rate and totals, pump starts, pump runtime, and alarm setpoints.

- i. Ventilation Control Screen: Provide a detailed graphical screen with all equipment and process information for the ventilations system including gas monitors level measurement and alarm setpoints, fan status, fan starts, fan runtime.
- j. Flow meter Screen: Summary of all flow meter instantaneous flow readings, flow totals for each meter, and daily/weekly/month influent and effluent flow totalizers.
- k. Sampler Screen: Display Sampler status and provide set point control for flow pace control and alarms.
- l. Chemical Metering Equipment Screen: Chemical metering equipment status and set point control for flow pace control to metering equipment and alarms.
- m. Maintenance Screen: Summary of pump starts and runtimes for each pump. Allows operators to monitor pump usage and determine maintenance schedules.
- n. Power Screen: Display of power data from the electrical power meter in the MCC. Includes current, voltage and frequency measurements for the 480V three phase system.
- o. Generator Screen: Automatic Transfer Switch (ATS) position, Utility power source status, Generator status (run/fail), low fuel alarm.
- p. Alarm Screen: Shows summary of all active alarms and allows each individual alarm to be enabled or disabled for maintenance.
- q. Trending: Configure AVEVA Insight to log all process data into the online Historian. Configure Historical trend screen allows process data logged into the Historian to be viewed in graphical format.
- r. Reporting: Configure AVEVA Insight to provide interactive reporting tools and coordinate with Owner and operator for the custom reports to meet Agency requirements.
- s. Data trending, logging and reports using the Insight software tools and cloud based system
- t. Common Navigation screen, login tools, time and date display, user and password.
- u. Set point screen to allow password-protected system set point changes for all control and alarm points.
- v. Pop up screens as needed for setpoint control, notifications or other common features.

- w. Additional screens and features not listed herein but required for a complete and operational SCADA application.
 - 5. Configure communication status monitoring and comms loss notification.
 - 6. Configure security functions per AVEVA software capabilities.
 - 7. Configure remote access via VPN to allow for secure remote access by Operator.
- B. Alarm Monitoring Software – WIN 911 Mobile
- 1. Alarm signals shall be programmed for each system alarm. An alarm event logger shall be included to indicate time and date for each alarm, when triggered and when acknowledged.
 - 2. All alarms will be programmed in the PLC for monitoring by the SCADA computer and WIN 911 mobile interactive alarm system.
 - 3. All alarms shall include adjustable de-bounce timers (5 sec) and enable/disable functionality for each alarm.
 - 4. Configure WIN-911 software for treatment system alarm monitoring and remote and interactive notifications. Configure up to 5 remote users, cell phone setup for each, testing and training for system operators to use the system and also adjust and configure schedules and users.

*** END OF SECTION **