SECTION VI.6. **PUMP SPECIFICATION**

Pentair/Aurora SERIES 3800 Specification

HORIZONTAL FRAME MOUNTED END SUCTION CENTRIFUGAL PUMPS

PART I – GENERAL

1.01 DESCRIPTION
The Contractor shall furnish materials, equipment and labor to furnish, install and test the pumping system complete with the pumps, motors, mounting bases, piping, valves and appurtenances, as indicated on the contract drawings and as herein specified.

1.02 INSTALLATION
The Contractor shall insure that the pumps and motors are properly installed with no pipe strain transmitted to the pump casing.

1.03 RESPONSIBILITY
To assure a properly integrated and compatible system, all equipment described in this section shall be furnished by the Pump Manufacturer, who shall assume full responsibility for the proper operation of the pumps and associated equipment.

1.04 SUPERVISION
The Contractor shall arrange for the Pump Manufacturer to provide a factory-trained representative as required for the purpose of supervising installation, start-up, final field acceptance testing, and providing instruction to the owner's operating personnel in the proper operation and maintenance of the equipment in this section.

1.05 REFERENCE STANDARDS
The work in this section is subject to the requirements of applicable portions of the following standards:

Hydraulic Institute Standards
IEEE Standards
NEMA Standards
OSHA Rules and Regulations

PART II - PRODUCTS

2.01 GENERAL DESCRIPTION
The pump shall be a centrifugal horizontal flexible-coupled end suction pump, Aurora Model 3804 or pre-approved equal. Pre-approval must be obtained a minimum of 5 days before bid date.

2.02 MATERIALS OF CONSTRUCTION
Casing.....Cast Iron (ASTM A48)
Impeller.....316 Stainless Steel (ASTM A276)
Shaft.....Steel (AISI C1045)
Shaft Sleeve.....Bronze (ASTM B62)

2.03 CASING
The casing will be of the end suction design with tangential discharge outlet. For suction piping diameters of 2" or less and discharge piping diameters of 1.5" or less, the suction and discharge connections shall be NPT threaded. For suction piping diameters of 2" or greater, the suction inlet and the discharge outlet shall be a bolt through flange connection, and tapped for pressure gages. Flange connections shall be ANSI 125# rated. The casing shall have tapped and plugged holes for priming and draining. The casing bore shall be large enough to allow "back pullout" of the impeller without disturbing the casing or suction and discharge piping. The casing shall have integral cast feet.

2.04 IMPELLER
The impeller shall be of the enclosed type, and investment cast. It shall be finished all over, the exterior being turned and the interior being finished smooth and cleaned of all burrs, trimmings, and irregularities. The impeller shall be dynamically balanced. The impeller will be keyed to the shaft, and fastened with a washer, gasket and capscrew.

2.05 MOTOR BRACKET AND SEAL PLATE
The seal plate and motor bracket shall be of a two piece design, and shall provide an adequate area for internal recirculation of the pumped fluid around the sealing medium.

2.06 MECHANICAL SEAL
Shaft sealing shall be accomplished by means of a mechanical seal with a Ceramic seat, carbon washer, Buna-N elastomers, and stainless steel metal parts.

2.07 SHAFT
The impeller shall be direct-coupled to the motor shaft. The motor shaft shall be machined to provide a keyway, and drilled and tapped to accept the impeller fastener. Stub shafts are not acceptable. The outboard shaft extension shall be machined with a keyway to accept a coupling to the driving unit. Lip seals shall be furnished on both the inboard and outboard shaft extensions, and a water slinger shall be furnished on the inboard shaft extension closest to the mechanical seal.

2.08 SHAFT SLEEVE
The pump shaft shall be fitted with a shaft sleeve to minimize shaft wear. The sleeve shall be sealed to the impeller hub by an O-ring, and shall be positively driven by a pin to the keyway. The use of adhesive compounds to fasten the sleeve to the shaft shall not be accepted.

2.09 POWER FRAME
The power frame shall house a single-row outboard regreaseable thrust bearing. Both bearings shall be selected for a 3 year minimum life at maximum load. The outboard bearing shall be locked in place by a retaining ring. The inboard bearing shall not be locked in order to accommodate thermal expansion of the shaft. Lubrication fittings shall be provided in convenient location. A bearing cartridge end cap shall be provided on the outboard side of the power frame to allow inspection of the thrust bearing without the need for disassembling the power frame housing.

2.10 FOOT SUPPORTS
The pump unit shall be supported from feet cast into the casing and a bracket mounted to the power frame.

2.11 BASEPLATE
The pump and motor shall be mounted on a groutable formed steel baseplate or a drip-rim baseplate with integral drip channels incorporated on each side. Each channel shall include an NPT drain connection and plug. The base shall be sufficiently rigid to support the pump and the motor without the use of additional supports or members.

2.12 COUPLING
A flexible coupling shall be provided to connect the pump shaft to the motor shaft. The coupling shall be of an all metal type with a flexible rubber insert. The entire rotating coupling assembly shall be enclosed by a coupling guard.

2.13 MOTOR
The motor shall be a NEMA configuration in accordance with the latest NEMA Standards, and shall have the following characteristics:
Enclosure.....Open Drip Proof/TEFC/X-Proof
Number of Phases.....Three
Cycles.....60 Hz.- capable of VFD
Voltages.....460 Volt
Speed.....1770 RPM
Horsepower.....40 hp
Each motor shall have a sufficient horsepower rating to operate the pump at any point within the manufacturer’s recommended operating range on the pump's head-capacity curve without overloading the nameplate horsepower rating of the motor, regardless of service factor. The motor shall have a service factor of at least 1.15. The service factor is reserved for variations in voltage and frequency.

PART III - PERFORMANCE

3.01 CONDITIONS OF SERVICE

The following conditions of service shall be strictly adhered to:
Number of Units.....3
Type of Drive.....VFD
Discharge Size.....3 in, minimum
Suction Size.....4 in, minimum
Design Capacity.....600 US gpm
Design Head.....164 ft
Efficiency at Design.....81%, minimum
Rotative Speed.....1800 RPM, maximum
Shut-off Head.....187 ft, minimum
Driver Horsepower..... 40hp, minimum
NPSHR at Design..... 8.94ft, maximum

3.02 INSPECTION AND FACTORY TESTS
Each centrifugal pump furnished under these specifications shall be tested at the factory to verify individual performance (VIP). Certified copies of all test reports shall be submitted to the Engineer for approval prior to shipment. Each unit shall be hydrostatically tested in accordance with the Hydraulic Institute Standards.

3.03 INSTALLATION AND ACCEPTANCE TESTS
A. The pumping units shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings by the Contractor.
B. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the manufacturer's recommendations.
Additional information is available from any Pentair Aurora authorized distributor.
Pentair reserves the right to make revisions to its products and their specifications without notice.

SECTION VI.7. ELECTRICAL SPECIFICATION

CSI SECTION 16010 ELECTRICAL GENERAL

FOLLETT ENGINEERING, PLLC 425-765-6304

1. GENERAL

A) SCOPE:

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.

B) DEFINITIONS:

a. The word "**provide**" shall be interpreted to mean furnish and install.

b. **"Owner"**.Lake Forest Park Water District

c. "**Contractor**" is the party who furnishes and installs all materials and equipment. This includes the Prime Contractor, Electrical Contractor, Control System Integrator, and all other Contractors and Sub Contractors.

d. "**Control System Integrator**" also referred to as the System Integrator or Integrator or control system manufacturer is the Party that furnishes all control components including motor controls, VFDs and motor control centers and designs the detailed control wiring diagrams plus the layout and assembly of the custom control panels.

e. "**Control System**" includes all equipment, instruments, computers and wiring for control and monitoring of all operating pumps and equipment. This includes custom control panels, motor control center, packaged control panels, and control equipment furnished with other systems and mechanical equipment. All sensing, transmitting, indicating, control and recording of all functions as specified and shown are also included in the control system.

f. **"System Programmer**" – Provides all programming and related service – has been pre-selected for this project to be furnished by the Owner.

C) GENERAL DESCRIPTION OF WORK:

a. The Contractor shall:

(1) 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 plans and these specifications.

(2) Provide identification (nameplates and wire tags) of all electrical equipment and wiring.

(3) Complete the wiring to, connection to, adjustment and calibration of, testing of equipment having electric motors and/or built-in or furnished electrical components. Install electrical components that are furnished with mechanical equipment.

(4) Complete the procurement, installation, wiring, connection, calibration, adjustment, testing and operation of all electrical devices, components, accessories and equipment which is not shown or specified but which is nonetheless required to make the systems shown and specified function properly.

(5) Provide the size, type and rating of motor control devices, equipment and wiring necessary to match the ratings of motors furnished with mechanical equipment.

(6) Provide adequate space for the electrical installation, including but not limited to, determination of access-ways and doorways, shipping sections, wall and floor space, and space occupied by mechanical equipment. Provide electrical equipment that fits in the areas shown on the drawings. All equipment shall be readily accessible for maintenance, shall have electrical clearances in accordance with NEC and shall be installed in locations that will provide adequate cooling.

(7) Provide detailed wiring diagrams showing all equipment and instrumentation connections and terminations.

(8) Check electrical equipment prior to installation so that defective equipment is not installed. Acceptance testing for electrical equipment shall be performed as discussed in Section 16921.

(9) Provide start-up, follow-up and training of the Owner's personnel for electrical systems. Make all corrective measures required during start-up. See specific requirements for training and start-up in other specification sections.

(10) 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, which occur during start-up.

(11) The VFDs, motor control, control panels, and instrumentation shall be supplied through the Control System Integrator and shop tested in the integrator’s shop.

D) EQUIPMENT COORDINATION

a. The Contractor is responsible to coordinate the equipment supplied from other manufacturers. This includes but is not limited to:

(1) Obtaining specific information on equipment ratings and sizes and verifying the electrical components supplied meet, or match the requirements such as voltage, phase, frequency, starter types, etc.

(2) Verifying the equipment supplied will fit within the space allocated.

(3) Coordination of equipment and the electrical power and control requirements. Provided in all sections of the specifications and drawings.

(4) Providing power and control equipment, wiring, and raceways to meet the requirements of the mechanical equipment supplied.

(5) Providing all necessary control wiring and components for any special requirements from an equipment manufacturer.

b. The Contractor shall verify as a minimum:

(1) Correct voltage, phase and frequency

(2) Size and space requirements

(3) Mounting requirements

(4) Correct motor starter type

(5) Proper coordination with the controls and control system Integrator.

c. Any discrepancies between the electrical and other equipment shall be brought to the immediate attention of the Engineer.

d. The Contractor shall take precautions to minimize instrumentation or control interferences that are created by the variable frequency drives (VFD's) or power wiring. All parallel runs of power wiring shall be separated from instrumentation and control wiring by a minimum of 12" and 18" to any VFD power wiring.

E) PROJECT DESCRIPTION:

a. In general the project consists of construction of a new booster pump station.

b. The following statements highlight the main portion of the electrical work:

(1) Coordinate with the local power utility and provide power service to the site and temporary service for construction power and power for the existing pump station during construction.

(2) Demolish existing equipment at the site and re-use instrumentation and other equipment as shown on the plans.

(3) Provide service entrance equipment and metering equipment per the serving utility's requirements

(4) Provide automatic transfer switch

(5) Re-use existing generator receptacle for the Districts existing trailer mounted generator connection.

(6) Provide motor control panels with power distribution equipment VFDs and motor starters.

(7) Provide a MCP – Main Control Panel with PLC for control and monitoring and alarming of all equipment.

(8) Provide new instrumentation.

(9) Provide lighting and receptacles, heating and ventilation equipment.

(10) Provide wire and raceways for all equipment power and control circuits.

F) TEMPORARY OPERATION AND CONSTRUCTION POWER:

1. CONSTRUCTION POWER:

a. Provide a separately metered temporary power service for construction power. Provide power for operation of all equipment during testing. Provide power for operation of the existing pump station during construction. All coordination with the utility and associated construction costs for temporary construction power shall be paid for by the Contractor.

b. The Owner shall pay the for the energy costs as billed by the utility on this “new” meter.

G) STANDARDS AND CODES:

a. Permits, licenses, approvals and other arrangements for work shall be obtained and paid for by the Contractor and included in the bid price.

b. Electrical work shall be executed in strict accordance with the latest edition of the National Electrical Code and local ordinances and regulations.

c. All electrical equipment, materials, construction methods, tests and definitions shall be in strict conformity with the established standards of the following in their latest adopted revision:

(1) Underwriters' Laboratories, Inc. (UL)

(2) National Electrical Manufacturers Association (NEMA)

(3) Canadian Standards Association (CSA)

(4) Electrical Testing Laboratories (ETL)

(5) Factory Mutual (FM)

(6) All applicable Washington State Codes and local City Codes.

d. All materials and equipment specified herein shall, within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.

e. 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.

H) CONTRACT DOCUMENTS:

a. The electrical layouts are generally diagrammatic. The location of equipment is approximate unless dimensioned. Exact locations and routing of conduits shall be governed by structural conditions and physical interference’s and by locations of electrical terminations on equipment.

I) REFERENCE DOCUMENTS:

a. The Contractor shall refer to the drawings, project data and shop drawings of other trades for additional details, which affect the proper installation of the work. Diagrams and symbols showing electrical connections are diagrammatic only, and so do not necessarily show the exact physical arrangement of the equipment.

J) SITE FAMILIARIZATION:

a. Before submitting a bid, the Electrical Contractor shall become familiar with all features of the site, which may affect the execution of the work. The Contractor shall take all field measurements necessary for the work and shall assume full responsibility for their accuracy. The Contractor shall take full responsibility for locating and avoiding all substructures. Any damage to existing equipment shall be repaired or replaced by the Contractor at a cost negotiated with the Owner.

K) GROUND SYSTEM

a. Provide grounding and ground system per the NEC.

b. Provide a minimum of two 10 foot x ¾" copper coated steel ground rods or more if required by the drawings. Use pressure type connectors for underground connections and bolted type for exposed.

c. Construct metallic raceways to provide a continuous ground path

d. Connect all electrical equipment enclosures to the ground system.

e. Nonelectrical equipment with metallic enclosures and metallic piping shall be connected to the grounding system as required by NEC.

f. Ground system shall be tested per IEEE standard 81. If greater than 2 ohms then additional ground rods shall be added and paid for as extra work

g. Bond ground system to metallic piping as required by NEC.

h. Bond ground system to building steel in at least one location and at other locations as shown on the drawings.

L) SUBMITTALS:

a. Project data shall be submitted in accordance with the general requirements and the following:

b. In the front of each submittal document, provide a list of any deviations to the contract documents: materials/products, or installation method that are different than specified.

c. Submittal documents shall be submitted via E-mail in PDF format. Separate Submittal e-mails shall be provided for each spec section. All products for each spec section shall be included in a single PDF document including the cover sheet

and index in **one single document**. Submittals shall be indexed and identified as follows:

(1) Email subject line shall be "*project name*, EI&C submittal *submittal #, spec section# - description."*

(2) Cover sheet with:

(a) The project name and submittal #

(b) Contractor's and sub-contractor's name, phone number, and email address.

(c) Index sheet showing each product being submitted.

(3) PDF index tabs per the electrical specifications by section and paragraph or equipment name e.g. provide a minimum of one tab section for each piece of equipment in all of the PART 2 PRODUCT Sections 2.01 - 2.**.

(4) Label each equipment submittal sheet with equipment name and number. Indicate location where each item of equipment submitted will be used on the job. Use equipment numbers when available.

(5) Identify specific options and cross hatch out any information that is not a part of the specific information for the submitted component.

d. Submittals shall include the manufacturer's name, address, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference. Include other information necessary to establish contract compliance of each item proposed to furnish.

e. Long lead items may be submitted separately – if pre-approved by the Engineer.

f. 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 comment.

g. I&C (Instrument & Control) submittals shall be provided with a Bill of Materials showing quantity, manufacturer's name, catalog number, and supplier name and phone number.

h. Certify on all submittals that the material being proposed conforms to the contract requirements. In the event of any variance, state specifically which portions vary and request a variance in writing.

i. Certify that all furnished equipment is able to be installed in the allocated spaces by stating on each item:
"This equipment will be able to be installed in the spaces allocated"

j. Shop Drawings shall be provided on 11" x 17" sheets maximum size, 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.

k. NOTE: submittals received that do not meet the requirements outlined above and in the individual spec sections will be returned without review.

l. Contractor should anticipate in the schedule that submittals will take a minimum of 4 weeks for comments to return.

m. The engineer will have a minimum of 2 weeks to review submittals and a minimum of 3 weeks to review I&C submittals.

2. PRODUCTS

A) NAMEPLATES:

a. Nameplates shall be provided on all electrical devices, (including but not limited to motor control equipment, MCC cubicles, control stations, junction boxes, panels, motors, instruments, solenoids, switches, indicating lights, meters, and all electrical equipment enclosures.)

b. Nameplates shall also be provided on all electrical panel interior equipment, including but not limited to: relays, circuit breakers, power supplies, terminals, contactors, and other devices.)

c. All nameplates shall include the equipment name and number (circuit number and function, if applicable).

d. Nameplates of all powered equipment (including instruments, motors, control panels, HVAC, etc.) and all switches, disconnects, and receptacles shall have included on the nameplate the power source (circuit and panel number, MCP/control pnl and circuit #, or MCC and unit number, etc.) that the equipment is fed from.

e. Nameplates on light switches and receptacles shall include the panel and circuit and also include application such as outdoor lights, computer receptacle, etc. if relevant. Nameplates on switches and receptacles can be printed thermal tape.

f. All motors shall have nameplates secured to the terminal box with 1/2” lettering or larger.

g. Nameplates shall be made of 1/16" thick machine engraved laminated phenolic having black letters not less than 3/16" high on white background or as shown on the drawings or other sections of the specifications. Nameplates on the interior of panels and on light switches and receptacles shall be White Polyester with printed thermal transfer lettering and permanent pressure sensitive acrylic; TYTON 822 or equal.

h. All nameplates shall include the equipment name and number (and function, and circuit number if applicable).

i. Provide warning nameplates on all panels and equipment, which contain multiple power sources. Lettering shall be white on red background.

j. Provide information or warning nameplates as required by the NEC or electrical inspector for identification of service disconnects, multiple service disconnects etc

k. Nameplates shall be secured to equipment with stainless steel screws/fasteners/straps. Epoxy glue may be used where fasteners are not practical if first approved by the Engineer.

B) WIRE MARKERS

a. Each power and control conductor shall be identified at each terminal to which it is connected. Conductors size No. 10 AWG or smaller shall have identification sleeves. Conductors shall be identified in accordance with Section 16145.

b. The letters and numbers that identify each wire shall be machine printed on sleeves with permanent black ink. The figures shall be 1/8 inch high. Sleeves shall be white tubing, sized to fit the conductor insulation. The sleeves shall be shrunk to fit the conductor with hot air after installation.

c. Wire markers shall be TMS Thermofit Marker System by Raychem Co., sleeve style wire marking system by W. H. Brady Co., or equal. Adhesive strips are not acceptable. Conductors No. 8 AWG and larger shall use cable markers of the locking tab type. Tabs shall be white plastic with conductor identification number permanently embossed.

C) RACEWAY MARKERS

a. Raceway markers shall be non metallic with raceway number stamped in 3/16-inch minimum height characters. Tags shall be attached to the raceway with 316 stainless steel wire.

D) THERMAL (TEMPERATURE) RATINGS OF EQUIPMENT TERMINATIONS:

a. Wiring and circuit breakers on this project are designed for 75^{O}C operation above 30 amperes; 60^{O}C for 30 amperes and below.

b. All products furnished on this project shall have electrical terminations rated for 60^{O}C for ampacities of 30 amperes or less and rated for 75^{O}C for ampacities above 30 amperes.

3. EXECUTION

A) STORAGE AND INSTALLATION ENVIRONMENT:

a. All electrical equipment shall be stored in a dry environment free from dust, moisture, sprays or vapors, which may be detrimental to their new condition. After installation of equipment, care shall be taken to protect all equipment from all dust,

moisture, paint and other spray, harmful vapors, etc. until final acceptance and certificates of occupancy have been obtained.

b. Equipment shall not be installed in indoor areas until the area is covered, dry and finished to the point that other work will not create dust, vapors, or moisture. Equipment with integral heaters and fans shall not be installed until power is available at the location and the heater and fan shall be energized within 6 hours of the equipment being installed.

B) SITE INSPECTIONS

a. Prior to final acceptance the Engineer will perform one or more site observation trips to develop a “punch list” of items deemed incomplete

b. Each punch list item shall be completed by the Contractor and checked off of the list. When all of the items on the list are completed or commented on, the list shall be signed by the Contractor and returned to the Engineer for verification.

C) FINAL ACCEPTANCE:

a. When all work is complete, the Contractor shall call the Engineer for the final acceptance testing inspections. The Electrical Contractor and System Integrator 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 anticipate a minimum of 4 hours to complete the final acceptance testing.

c. Prior to the Contractor calling for this observation, the Contractor shall have completed all items of work, including wire markers, nameplates, final tests and final test reports. All equipment shall be checked for proper operation and all signals verified for correct calibration and wiring.

d. Final acceptance will not be given until:

(1) All work is complete

(2) All “site inspection” punch-lists are checked off and returned to the Engineer

(3) All test reports are received

(4) All O&M manuals are received

(5) All spare parts are received

(6) All instrument test forms are received

(7) All project record drawings are received.

D) PROJECT RECORD DRAWINGS:

a. A set of drawings shall be maintained at the job site (by the Electrical Contractor) showing any deviations in the electrical systems from the original design.

b. This set of drawings shall be readily available for inspection by the Engineer at all times.

c. Another complete set of drawings shall be marked up in the office showing the changes made on the field set of drawings. All changes shall be clearly marked in red on the drawings. Drawings shall be submitted to the Engineer at the completion of the project.

d. A set of electrical drawings marked in red to indicate the routing of conduit runs, shall be submitted to the Engineer for review at the completion of conduit rough-in and prior to cover or pouring of concrete.

E) GUARANTEE:

a. The Contractor shall guarantee his work and all components thereof, excluding fuses, incandescent, LED and fluorescent lamps for a period of 1 year from date of acceptance of the installation. The Contractor shall remedy any defects in workmanship and repair or replace any faulty equipment that shall appear within the guarantee period without additional cost to the Owner.

F) CLEANUP:

a. The premises must 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. At the completion of the job, all equipment and fixtures shall be left clean and in proper condition for their intended use.

b. All motor control equipment and control panels shall be cleaned inside and out at the completion of the project.

G) TESTS:

a. Testing for installed feeder cables and motors is required as specified in other Sections. Test reports shall be submitted to the Engineer prior to final acceptance. All tests shall be performed in accordance with the applicable sections of NETA.

b. Where specified in the individual product specification section, factory tests shall be performed at the place of fabrication and performed on completion of manufacture or assembly. The costs of factory tests shall included in the contract price.

H) MAINTAINED OPERATION REQUIREMENTS:

a. The existing pump station is an existing and operating facility. The pump station must remain fully operational during construction.

b. The Contractor shall submit a detailed plan with timelines and dates for the transition of the power system and any other anticipated interruptions of the existing pump station’s operation.

c. All changes in pump stations operations shall be directly coordinated with the Owner. All power outages shall be coordinated with the Owner and the Utility.

END OF SECTION

SECTION 16145

MISCELLANEOUS ELECTRICAL

A GENERAL

1 DESCRIPTION OF WORK:

a. This section covers furnishing and installing miscellaneous electrical devices and equipment and other wiring devices indicated on the drawings.

2 STANDARDS AND CODES:

a. All materials and equipment specified herein shall within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.

b. All materials and equipment specified herein shall conform to all applicable NEMA, ANSI and IEEE standards.

c. All materials and equipment specified herein and their installation methods shall conform to the latest published version of the National Electric Code, N.E.C.

3 COORDINATION

a. The Contractor is responsible for coordination of mechanical equipment, fans, louvers, heaters, motors, starters, etc. and the electrical power and control requirements. Provided in this section and other sections of the specifications and drawings.

b. The Contractor shall provide power and control equipment, wiring, and raceways to meet the requirements of the mechanical equipment supplied.

c. The Contractor shall verify as a minimum:

1. Correct voltage, phase and frequency
2. Correct motor starter type
3. Proper coordination with the controls and control system Integrator.

d. The Contractor shall provide all necessary control wiring and components for any special requirements from an equipment manufacturer.

e. Any discrepancies between the electrical and mechanical equipment shall be brought to the immediate attention of the Engineer.

4□ SUBMITTALS:

a□ In accordance with the "submittals" requirements in Section 16010, submit catalog data showing material information and conformance with specifications. The intended use of each item shall be indicated.

b□ Submittal documents shall be submitted via E-mail in PDF format. Separate Submittal e-mails shall be provided for each spec section. All products for each spec section shall be included in a single PDF document including the cover sheet and index in one single document. submittals shall be indexed and identified as follows:

□1□ Email subject line shall be "*project name*, EI&C submittal *submittal #, spec section# - description."*

□2□ Cover sheet with:

□a□ The project name and submittal #

□b□ Contractor's and sub-contractor's name, phone number, and email address.

□c□ Index sheet showing each product being submitted.

□3□ PDF index tabs per the electrical specifications by section and paragraph or equipment name e.g. provide a minimum of one tab section for each piece of equipment in all of the PART 2 PRODUCT Sections 2.01 - 2.**.

c□ A copy of this specification section, with addendum updates included, and all referenced and applicable sections, with addendum updates included, with each paragraph check-marked to indicate specification compliance or marked to indicate requested deviations from specification requirements. Check marks (√) shall denote full compliance with a paragraph as a whole. If deviations from the specifications are indicated, and therefore requested by the Contractor, each deviation shall be underlined and denoted by a number in the margin to the right of the identified paragraph, referenced to a detailed written explanation of the reasons for requesting the deviation. The Engineer shall be the final authority for determining acceptability of requested deviations. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal with no further consideration.

d□ Provide all electrical information – wire diagrams, terminal information and numbering and electrical / power data.

e□ Submit verification that stainless steel hardware will be used as required by this specification.

B PRODUCTS

1 RACEWAYS

? GENERAL

a All wiring shall be installed in raceways

b Ground Conductor:

1 All raceways shall contain a minimum of one continuous copper equipment grounding conductor sized in accordance with the N.E.C.

? 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. Areas which fall under two or more of the following classifications shall conform to the minimum requirements of all of the area classifications listed for that area.

b Outdoor and Damp Areas:

1 All outdoor areas, pump room

a Raceway indoors shall be EMT,.

b Exposed raceways outdoors shall be IMC or Sch 40 PVC

c Threaded fastening hardware and rods shall be 316 stainless steel. Raceway supports such as channel, clamps, and brackets shall be 316 stainless steel or aluminum or non-metallic.

d Panels and boxes shall be NEMA 3R - aluminum, stainless steel or non-metallic (or as shown on the drawings).

c General Purpose Areas: All other areas not described above.

1 Raceway indoors shall be EMT.

2 Raceway concealed in walls or ceilings for general purpose lighting and receptacle circuits may be EMT.

3 Exposed boxes shall be NEMA 12. Concealed boxes may be NEMA 1. Boxes poured in concrete shall be Cast.

? **RACEWAY APPLICATION:**

a. Unless otherwise shown on the drawings, CONDUITS shall meet the requirements of the “area classification” listed above and shall be:

.a. PVC for all underground raceways and all raceways entering vaults and underground structures.

.b. EMT for all exposed and concealed raceways inside the pump building

b. Unless otherwise shown on the drawings, CONDUITS BELOW GRADE shall be:

.a. Schedule 40 PVC:

.i. Sweeps and risers for transition of PVC from below grade to above grade that penetrates the floor slab shall be IMC.

c. ALL CONNECTIONS TO VIBRATING EQUIPMENT or motors shall be:

.a. liquidtight flexible metallic conduit for indoor, non corrosive areas and all motor leads from VFD’s.

d. All raceways materials, sizes, etc. for UTILITY SERVICE shall be per the serving utilities requirements.

? **CONDUIT:**

a. Galvanized Rigid Steel Conduit (GRC):

.1. Rigid conduit shall be steel, galvanized. Terminations shall be by means of threaded hubs or double locknuts and insulating grounding type bushings.

b. Intermediate metal conduit (IMC):

.1. Intermediate metal conduit shall be of steel and shall be galvanized. Fittings shall be threaded.

c. Flexible Conduit (LFS):

.1. Flexible conduit shall be interlocking single strip, galvanized and shall have a polyvinyl chloride jacket extruded over the outside to form a flexible watertight raceway. Non-metallic flexible conduit shall have non metallic threaded fittings.

d. Nonmetallic Conduit(PVC):

.1. Nonmetallic conduit shall be rigid PVC, Schedule 40 or 80. PVC installed above grade shall be UV resistant schedule 80. Fittings shall be of the same material as the raceway and installed with solvent per the manufacturer's instructions. Conduit, fittings and solvent shall all be manufactured by the same manufacturer.

e. PVC Coated Rigid Steel Conduit (PGRC):

.1. Coating: A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of rigid steel conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the

plastic. The thickness of the PVC coating shall be a minimum of .035" (35 mil) (40 mil nominal).

f□ Aluminum Conduit:

□1□ Shall be rigid aluminum conduit: ANSI C80.5; aluminum, threaded.

g□ Electric Metallic Tubing (EMT) shall be rigid galvanized steel

? **BOXES AND FITTINGS:**

a□ General

□1□ Materials for fittings shall be chosen to satisfy the requirements of - Area Classification described above.

□2□ Junction boxes, terminal 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.

□3□ Boxes larger than 9”x9” shall be hinged.

□4□ Cast fittings and boxes shall be:

□a□ zinc electroplated cast ferrous alloy:.

□b□ 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 done before finishing.

□c□ The cover plate shall be of similar cast ferrous alloy material and finish. A full body neoprene gasket shall be provided with the cover. Stainless steel screws shall be provided for all covers.

□5□ All screws, nuts, bolts, straps, rods and other hardware used with supports, fittings and boxes shall be 316 stainless steel.

? **HANDHOLES AND VAULTS:**

a□ **Handholes and vaults** are specified on the civil plans

? **CONDUIT & CABLE SUPPORTS:**

a□ Rivet-type or Zamac fasteners are not allowed. All fasteners between channel, strut, etc. and walls shall be removable with a screwdriver.

b□ Support materials in general purpose areas may be hot-dip or electro-galvanized. All support materials used in damp areas, pump rooms, or outdoor, or corrosive areas shall be NEMA 4x Aluminum, Stainless steel, or non-metallic.

c□ All screws, nuts, bolts and other hardware used with conduit and cable supports shall be 316 stainless steel.

2□ CONDUCTORS:

a□ All conductors shall be stranded copper. Insulation shall be THW, THWN, or THHN, chosen to satisfy environmental conditions. Conductors used for power circuits shall not be smaller than No. 12. Control conductors may be No. 14.

3□ SHIELDED SIGNAL CABLE:

a□ Signal conductor cable shall be AWG #16 individually twisted, shielded pairs. BELDEN #8719, or equal. Conductors shall be tinned copper with color coded 90 degrees C PVC insulation and individual conductor jacket of nylon. Shielding shall be aluminum polyester 100% shield coverage with drain wire. The cable shall have an overall PVC jacket. The insulation system shall be rated for 300 volts.

b□ For applications where 600 volt insulation is required, use

□1□ BELDEN 1120A

□2□ #18 TWSP, stranded wire.

c□ 600 volt insulated signal wire shall only be used where required by Code.

4□ CONNECTORS

a□ All wiring shall be continuous from point to point – no splices of any kind are allowed. All control and signal wire shall land on numbered terminals.

b□ Ideal Industries "Wing Nut" or 3M Company "SCOTCHLOCK" pre-insulated connectors may be used for general purpose lighting and receptacle circuits for splices and taps in conductors No. 10 AWG and smaller. For No. 8 AWG and larger conductors, utilize T&B compression connectors. Compress using recommended die and tools.

c□ For connections of wire to cord to removable equipment provided with integral cords (such as floats, transmitters, limit switches, aerators, submersible pump motors, etc.) Provide junction box with terminals and spade/lug type terminations and coat with liquid insulation – Performix Liquid Tape or equal.

d□ For connections of wire to cord to Submersible motors of all size wire use a water proof motor stub insulator. Thomas and Betts multi splice insulator MSLT112-4 or equal.

5□ SPLICE INSULATION:

a□ Splice insulation shall be equal to the conductor utilized.

b□ Insulate all permanent splices that are underground or in damp or corrosive environments 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.

6 MOTOR TERMINAL SPLICE INSULATION:

a. Provide motor terminal splice insulation in the motor connection box that 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

7 WIRE MARKERS:

a. Field installed wire markers shall be pre-printed, heat shrink type sleeves, Thomas&Betts Type HVM, Tyton Type THS or approved equal. See paragraph below for marking requirements.

8 SWITCHES AND RECEPTACLES:

a. Standard wall switches shall be single-pole, or double-pole, three-way, as shown on the drawings or as required for the application. Switches shall be AC quiet type rated 20 amp, 125/277 volt with screw terminals. Wiring devices shall be ivory colored for general use office areas, and black when installed in mechanical rooms or when mounted on dark walls. Receptacles on emergency or backup power shall be labeled or color coded. ARROW HART, BRYANT, HUBBELL, P&S or equal.

b. Weather proof switches for use in damp, corrosive or outdoor applications shall be

i. Die cast aluminum housing with lever type switch CROUSE-HINDS, DS185

ii. or non metallic, UL marine listed, CARLON, E98TSC or equal.

c. Weather proof receptacles for use in damp, corrosive or outdoor applications shall be

i. Die cast aluminum with spring and gasketed covers CROUSE-HINDS, WL series

ii. or non metallic, CARLON or equal.

d. Provide GFI receptacles where required by the NEC.

e. Per the nameplate requirements, provide circuit and panel data labels on all switches and receptacles and label all light switches with function.

f. Wall switches for areas classified as hazardous per NEC, as described herein or shown on the drawings shall be tumbler type, front operated, CROUSE-HINDS Type EFS or approved equal.

? PLATES:

a. Scope: Provide plate for each wiring device, for each signal or communication outlet.

b. Device plates on flush devices, in general, shall be satin finish stainless steel Sierra 302 stainless steel line or approved equal, modern classic design, corrosion

resistant. Special finish plates shall be provided to match special paneled walls as directed by Architect.

c Device plates for switches and receptacles in outdoor areas shall have weatherproof plates with hinged cover and stainless steel screws. Sierra Electric WP series or equal.

d Plates on exposed wiring shall be of metal, of the same manufacture as the conduit fittings; specifically suited for device and fitting used.

e Blank, Bushed or Special Outlet Plates: Provide for all signal communication system outlets as required.

? **SPECIAL ACCESSORIES**

1 Provide accessories such as junction boxes, outlet boxes, etc. necessary to mount switches and receptacles in a proper and approved method.

9 DRY TYPE TRANSFORMERS

a Dry type transformers shall be constructed of heavy gauge sheet steel. Coil and terminal chamber shall be constructed with guarded opening for ventilation and convection cooling. Transformer shall be connected for the application. Unless otherwise shown or required for the application, primary coil shall be delta connected, secondary coil wye connected.

b Separate primary and secondary windings shall have Class H insulation and shall be rated for continuous operation at rated kVA with temperature rise of not over 150 degrees C above a 40 degree C ambient, with a maximum hot spot temperature of 220 degrees C. Windings, core and coil assembly shall be treated and built to resist the effects of dirt and moisture.

c Unless otherwise noted or shown, transformers shall be provided with a minimum of four full capacity taps, minimum of two 2-1/2 percent above and two 2-1/2 percent below normal (rated) primary voltage.

d Transformers furnished shall have a continuous rating of not less than the size noted on the drawings.

e The secondary neutral terminal on three-phase K-rated transformers shall be sized for 200% of secondary phase current.

f Provisions for external connections shall be made by means of a terminal board employing lugs compatible for the external conductors to be installed.

g The core of the transformer shall be grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE ANSI standards.

h Provide grounding per NEC.

i. Provide enclosures per the requirements of the area installed – NEMA 3R for outdoor and damp areas, NEMA 12 for indoor areas

j. Acceptable manufacturers for dry type transformers shall be General Electric, Cutler Hammer, Square D, Heavy Duty and approved equals.

10. PANELBOARDS

a. Panelboards shall be rated at proper voltage and current for intended use with bus bars of tin plated copper or aluminum. Panels shall have phases, voltage and current ratings as shown on the drawings. Panels shall have 100 percent neutral, with equipment ground bar, unless noted otherwise. Panelboards shall be dead front.

b. Panels shall have as a minimum the number of circuits shown on the panel schedules on the drawings.

c. The following interrupting capacity shall be considered minimum. Other ratings shall be as specified on the drawings.

1. 240V and 208Y/120V – sub-fed Panelboards 10,000 AIC symmetrical
2. 240V and 208Y/120V – Service Panelboards 20,000 AIC symmetrical
3. 480V Panelboards 25,000 AIC symmetrical

d. Provide service entrance rated panelboards where shown on the plans or required by the NEC.

e. Provide enclosures per the requirements of the area installed – NEMA 3R for outdoor and damp areas, NEMA 1 for indoor areas or as shown on the drawings.

f. Mount breakers in all panelboards so that breaker handles operate in a horizontal plane. Circuit breakers shall be bolt-type only. Provide common trip on all multiple pole breakers.

g. Where noted, provide spare breakers, complete for future connection of wiring circuits. Where "Space Only" is indicated for breakers, provide all bussing and breaker mounting hardware in the panelboard; provide steel knockouts in dead front metal closure of unused part of panel. If any steel knockouts are removed, provide breakers in such spaces or approved cover plates. Open spaces are not permitted.

h. Panelboards shall be flush or surface as indicated; tight closing doors without play when latched. Where two cabinets are located adjacent to each other in finished areas, provide matching trim of the same height.

i. Provide cabinets of sufficient dimensions to allow for future expansion and addition of circuit breakers within the panelboards as indicated on drawings.

j. Provide lock for each cabinet door. All Electrical distribution equipment locks to be keyed identically.

k. Fasten panelboard with machine screws with oval countersunk heads, finish hardware quality, with escutcheons or approved trim clamps. Clamps accessible

only when dead front door is open are acceptable. Surface mounted panelboards with fronts greater than 48 inches vertical dimension shall have trim hinged at right side in addition to hinged door over dead front.

l Provide factory standard lacquer or enamel finish, ASA #49 gray.

m Provide Surge arrestors , with indicators, where shown on the one-line diagrams to protect against overvoltage transients. JOSLYN J9200 series with protective capacitor GE model 9L18 or equal. Select proper components for the application as shown on the drawings.

n Numbering and buss arrangement shall be as shown on the Panel Schedules on the drawings.

o Provide a type written circuit directory card for each panelboard with the load name, number, location and kVA.

p Provide engraved (color layer - engraved through outer layer) plastic name plate with 1/2 inch high characters for panel identification (for panel name); attached with stainless steel screws to each panelboard front. Emergency system - white on red; Normal system - black letters on white. Include voltage, phase and wire (i.e., 208Y/120V, 3 phase, 4 wire) in 3/8 inch characters.

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

r For each branch circuit panelboard: Provide neatly type written as-built information for each panelboard by circuit with its proper load designation. Mount the panelboard circuit directory inside the door of each panelboard in a clear plastic sleeve. Provide one spare blank card for each card used.

s Close all openings in dead front with closures manufactured for the purpose or install spare breakers.

11 SURGE SUPPRESSION:

1 Where surge suppressor (SPD or TVSS) is specified or shown on the drawings, provide integral surge suppression device with the following minimum characteristics:

a Surge Current per phase – 120kA

b Surge Current L – N 60kA

c IEEE C3 Wave (10kA) – 9,000

2 Unit shall have overcurrent protection, infrared and thermal detection - Include diagnostic package and direct bus bar connection and 10 year warranty – Cutler Hammer Clipper CPS-S or equal.

12 FUSES:

a Fuses shall be of the type and amperage indicated on the drawings. The voltage rating shall be appropriate for the application indicated. The fuse types indicated on

the drawings imply a certain set of fuse characteristics. No substitutions of fuse types will be allowed without written approval from the Engineer.

b. All fuses used on the project shall be provided with “blown fuse” indicators.

c. Where fuses in motor circuits are indicated but not sized, provide Manufacturer's recommended fuse size based on actual motor installed.

d. Provide in-line or integrally-mounted fuse clips on control power or low-voltage transformer.

e. Provide fuse puller or pullers for fuse sizes used.

f. Provide surface mounted cabinet, sized to store required spare fuses at location coordinated with Owners Representative.

g. Provide a minimum of two spare fuses for each fuse used.

h. Acceptable Manufacturers:

1. BUSSMAN
2. GOULD SHAWMUT
3. LITTLEFUSE
4. RELIANCE

13. MOLDED CASE CIRCUIT BREAKERS:

a. Molded case circuit breakers shall be quick-make and quick-break type. They shall have wiping type contacts. Each shall be provided with arc chutes and individual trip mechanisms on each pole consisting of both thermal and magnetic trip elements. Two and three pole breakers shall be common trip. All breakers shall be calibrated for operation in an ambient temperature of 40 degrees C. Molded case circuit breakers shall be trip-free. Each breaker shall have trip indication independent of the ON or OFF positions.

b. Breakers shall have lugs UL listed for both copper and aluminum.

c. Circuit breakers shall be capable of accepting the cable shown on the drawings. Circuit breakers not capable of accepting the cable shown shall not be acceptable.

d. Breakers shall have the interrupting rating and trip rating indicated on the drawings.

e. All breakers that serve motor loads shall be provided with disconnect handle mechanism to lock out the circuit in the open position

14. DISCONNECTS:

a. Provide local equipment disconnects only if required by the manufacturer or NEC.

b. Disconnect’s rating shall be chosen by the Contractor to meet the requirements of the equipment served.

c. Switch shall be heavy duty type, shall be quick-make quick-break and shall be horsepower rated. Switch shall have blades as required to open all ungrounded conductors and shall be single throw unless noted.

d. Enclosure shall be suitable for location in which mounted.

1. Enclosures located outdoors or in damp or corrosive areas shall be NEMA 4X, aluminum or stainless steel.

e. Fusible disconnects shall be as above with addition of fuse space and clips to accept Class R fuses. Use only where required by equipment manufacturer to meet UL installation requirements.

f. Disconnects for motor loads shall be lockable in the open position

15. MOTORS

? GENERAL

a. Unless specifically accepted, all motors shall be of the "energy efficient" or "energy saver" type which meet the minimum efficiencies required by the Washington State energy codes.

1. All Motors shall be suitable both electrically and mechanically to drive the connected equipment under any and all modes of operation without exceeding the FLA (Full Load Amps) rating of the motor.

b. All motors shall be suitable for the environment in which they are to be installed. The environment in which motors will be installed in this project will be 100% humidity continuously.

c. Motor voltages shall be chosen to meet the requirements of the electrical system. The Contractor shall choose the motor voltages to meet what is shown on the plans.

d. Motor enclosures shall be totally enclosed fan cooled (TEFC) unless otherwise specified or required by the environment installed. Provide explosion proof non-ventilated - (XPNV) or fan cooled (XPFC) motors in hazardous areas.

e. All single-phase motors shall be self-protected. Single phase motors shall be provided with start capacitors if necessary for proper operation of the motor. The start capacitors shall be located within the motor housing.

f. Enclosed Motors: Provide drain plugs for non-explosion proof motors and drain and breather for explosion proof motors.

g. Finish: Provide a prime and final finish of the manufacturer's standard colors.

h. Provide imbedded thermostats for thermal alarm or motor cut out for all motors 40 Hp and above unless otherwise shown.

i. Provide a terminal connection box two sizes larger than normal to allow extra room for motor feeder splices. Refer to Motor Terminal Splice Insulation requirements.

j. Provide NEMA Class B insulation, minimum, with additional nonhygroscopic moisture protection which will maintain a minimum resistance of 1.0 megohms after 168 hours of exposure at 100% humidity.

k. Provide motors with a 1.15 service factor at maximum motor operating load.

? **MOTORS ON VFDS**

a. Motors on VFD's shall be inverter duty and rated for use with VFD's. Insulation rating shall be 2100 volts minimum. The Contractor shall coordinate between the VFD and motor manufacturers to provide a motor/VFD combination suitable for the application.

b. Provide motors with adequate cooling for the lowest expected speed for load served.

c. Any line terminators, filtering devices, harmonic filters, line reactors, or other devices required for proper operation of the motor/VFD combination shall be provided and installed by the Contractor at no extra cost to the Owner.

1. For motors on VFD's, Provide proof of inverter duty rating and insulation rating as specified.

16. HARDWARE

a. The Contractor shall provide any necessary hardware for mounting equipment and devices. The mounting hardware shall be made of materials suitable for the environment installed. Provide materials made from aluminum, non-metallic, or stainless steel in outdoor, damp, or corrosive areas.

B. EXECUTION

1. GENERAL

a. Provide services of an authorized representative of manufacturer to visit site of work and inspect, check, adjust if necessary, and approve equipment installation.

b. Assure that equipment manufacturer's representative is present when equipment is placed in operation.

c. Verify that equipment representative revisits job site as often as necessary until all trouble is corrected and equipment installation and operation are satisfactory, in opinion of Engineer.

d. Verify that motor overcurrent protection is in accordance with the N.E.C.

e. Verify the motor protection and control is in accordance with the equipment manufacturers requirements.

2. WIRE & RACEWAY SIZING

a. The contractor shall size wire per NEC for the load being served. Raceways shall be sized per NEC for the wire or cables installed. Scheduled raceways and wire sizes are minimum size and contractor shall upsize if required for installation per the NEC.

b. Size pull and terminal boxes per NEC. Pull box sizes, if shown on the drawings, are minimum size and the contractor shall upsize if required by NEC.

3. OUTLETS AND SWITCHES:

GENERAL

a. For all receptacles, switches, and other related devices of the lighting and receptacle system, provide all necessary raceway and wire for a complete installation.

b. Center all outlets with regard to building lines, furring and trim. Symmetrically arrange outlets in the room. Satisfactorily correct outlets improperly located or installed.

c. Set outlets plumb and extend flush outlets to the finished surface of the wall, ceiling or floor without projecting beyond same.

d. Install symmetrically all receptacles, switches and outlets shown on the trim and where necessary, set the long dimension of the plate horizontal or gang in tandem.

e. Outlets in outdoor areas or wet areas shall be GFI – provide GFI outlets in other areas as required by Code.

MOUNTING HEIGHTS:

a. Unless otherwise noted, wall mounted outlet devices shall generally be 24 inches above the floor, 18" in architecturally treated areas. In basement, underground or in areas subject to flooding, outlets shall be 36” above the floor.

b. Switches shall be mounted 48 inches above the floor.

c. Outlets mounted over work tables, desks and counters shall be 2”- 6” above the work surface.

4. GENERATOR RECEPTACLES

a. Where receptacles or plugs are called out for portable generator connections, coordinate the mounting location with the owner prior to installation.

5 RACEWAYS

? GENERAL

a Not all conduits/raceways are scheduled. Wire diagrams and oneline diagrams show wiring requirements. Provide all necessary raceways for wiring as shown on the drawings.

b For all power and control equipment, provide all necessary raceways and wire per plans and specifications even if not specifically shown on the plans.

c Raceway routing shown on plans is general in nature, unless otherwise indicated on the drawings, the Contractor shall be responsible for determining conduit routing that conforms to the installation requirements required by the plans and specifications.

d The number of directional changes of a conduit shall be limited to 270 degrees in any run between pull boxes.

e Conduit runs shall be limited to a maximum of 400 feet, less 100 feet or fraction thereof, for every 90 degrees of change in direction.

f In general, conduit inside structures shall be exposed unless otherwise specified or indicated on the drawings. No conduit shall be exposed in water chambers unless so indicated on the drawings.

g Provide raceways/conduits per the conduit and wire schedule and additional as necessary to meet the requirements of the wiring.

h Scheduled conduit sizes are minimum. Contractor shall upsize conduits if necessary or if required by the NEC.

i Non scheduled conduits shall be a minimum of ¾" or sized per the NEC for the wiring installed plus 20%.

j Conduit across structural joints where structural movement is allowed shall have an O-Z "Type DX" or Crouse-Hinds "Type XD," bonded, weathertight expansion and deflection fitting of that conduit size.

k Separate conduits of different voltages by a minimum of 2" – separate signal wire conduits from all other types of conduits by a minimum of 6".

l All conduits shall be a minimum of 3/4".

m Conduits entering underground structures shall be made water tight – see "handholes and Vaults" for more requirements.

? HANDHOLES AND VAULTS:

a Conduits entering energized equipment shall have both conduit ends sealed with a waterproof duct sealing compound - WATERGUARD Industrial Encapsulant or equal. Where conduits enter through sides of handholes the penetration shall be made watertight.

b Provide a minimum of 12 inches deep of ¾ to 1” drainage gravel under entire surface and extending 12 inches beyond the outside edge of the structure in all directions - of all vaults and handholes.

c All wire installed in handholes and vaults shall be neatly bundled and racked to the handhole or vault side walls.

6 WIRE AND CABLE INSTALLATION

a Splices in power and control and signal wires or cables is not allowed. All wire transitions shall be done on terminals.

b Keep all conductors within the allowable tension limits during installation. Lubricants for wire pulling, if used, shall be approved for the insulation and raceway material. Observe cable manufacturer's and industry standard cable bending radius recommendations.

7 WIRE AND CABLE TERMINATION:

? GENERAL

a Power conductors, No. 8 AWG and larger may be terminated directly in box-type lugs.

b Solid conductors (when allowed for lighting and receptacle circuits) of #10 and #12 may be directly terminated to screw terminals.

c For any power, control, or signal wire terminating on screw type terminals; provide spade or ring tongue type terminations.

d Stranded control conductors may be directly terminated in box type terminals at control panels. Insulated terminals shall be used also on all stranded instrumentation wiring.

e 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.

f Special instrumentation cables shall be terminated in accordance with the recommendations of the manufacturer of the equipment and subject to review by the Engineer.

g No splices shall be used in power, control and/or signal wiring. The wiring shall be continuous from point-to-point. Extending existing cables will not be allowed except where shown on the drawings.

? 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 in accordance to the following.

- □i□ h = Control power hot (usually 120v or 24v)
- □ii□ n = neutral
- □iii□ g = ground
- □iv□ c = control (use if none of the above letters apply)
- □v□ p = power (usually 480v)
- □vi□ s = signal (usually 4-20ma or 1-5v) (use if none of the above letters apply)
- □vii□ B = DC + and –

b□ PLC input or output (S=slot number and I = card input number: for example slot 3 input 7 = 3-07)

? **WIRE MARKING:**

a□ All power and control conductors shall be tagged; including conductors in instrument and relay compartments of motor control centers, in control panels, instrument panels, field panels and control stations, as well as connections to mechanical equipment, shall be tagged at each end with legible, permanently coded tight fitting wire-marking sleeve showing the complete wire designation.

b□ Wire marking lettering shall be bold and type written.

c□ Wiring within a single enclosure shall be marked with the basic wire and terminal number at each end.

d□ Control and signal wires that interface to PLC I/O shall be marked so that the number relates to the PLC slot and I/O number – this is the same number as the terminal number.

e□ All field wiring shall have wire labels at each end. The labels shall be marked with the output terminal number at the original equipment (control panel, MCP, RCP, LCP or MCC) or remote device terminal # (if applicable).

f□ For wire that terminates in at a control panel at both ends or a control panel and an MCC, the priority for the numbering shall be as follows

□1□ MCP 2. RCP 3. MCC 4. LCP

END OF SECTION

ATTACHMENT: ELECTRICAL SYSTEM TEST REPORTS

ELECTRICAL SYSTEM
DESCRIPTION DATA

SERVICE DESCRIPTION:
nominal voltage, phase to phase
phase to neutral - single or three phase-
number of conductors _____

SERVICE CONDUCTORS:
phase size and insulation type _____
neutral size and insulation type _____
ground size and insulation type _____

SERVICE DISCONNECT DESCRIPTION:
circuit breaker or disconnect switch _____
size (amps) _____
fuse (amps) _____

MEASURED CONDITIONS		DATA
Operating Load Voltage	Volts	Vab_____Vbc_____Vca_____
		Van_____Vbn_____Vcn_____
Operating Load Feeder Current	Amps	Ia_____Ib_____Ic_____
Conductor Insulation Megohms Resistance (record the indicated measurement for each of the following circuits:)	a-b_____b-c_____c-a_____	
	Megohms	a-g_____b-g_____c-g_____

1. Service Feeder
2. Pump Feeders

16145 - MOTOR DATA AND TEST REPORT

EQUIPMENT NAME AND NUMBER: _____

EQUIPMENT SPECIFICATION SECTION: _____

MOTOR STARTER LOCATION _____

CONTRACTORS REPRESENTATIVE DATE _____

MOTOR NAMEPLATE DATA

MFR Name/Model No. _____
Voltage/Phase/HP _____
FLA/LRA _____
Service Factor _____
Efficiency Index (or percent) _____
NEMA Design _____
Code Letter _____
Insulation Type _____
Temperature Rise _____
Ambient Temperature _____
RPM _____
Enclosure _____
Thermal Trip Setting _____
Space HTR: Watts/Volts _____
Other Data _____

MOTOR STARTER INFORMATION
Manufacturer/Type _____
Overload Heater No _____

* RECORDED FULL LOAD DATA	VOLTS	A-G_____	B-G_____	C-G_____	
FULL LOAD OPERATING VOLTAGE	VOLTS	A-B_____	B-C_____	C-A_____	
FULL LOAD OPERATING CURRENT	AMPS	A_____	B_____	C_____	
INSULATION RESISTANCE (deenergized)	MEGOHMS	A-G_____	B-G_____	C-G_____	
MOTOR CIRCUIT RESISTANCE	OHMS	A-B_____	B-C_____	C-A_____	

* VOLTAGE & CURRENT READINGS SHALL BE TAKEN AT THE CLOSEST ACCESSIBLE POINT TO THE LOAD

END OF SECTION

PART I. SECTION 16145

LOAD TRANSFER SWITCHES (ATS)

1. GENERAL

A) DESCRIPTION OF WORK

a. This section provides equipment and installation for load transfer switches automatic transfer switch (ATS).

b. Transfer switch shall be well documented with clear wiring diagrams and submittals shall include wiring diagram showing clearly all connections for field wiring with terminal numbering.

c. Provide indicating lights, switches, meters, nameplates, and controls as shown on the drawings and specified herein.

B) STANDARDS AND CODES

a. All materials and equipment specified herein shall within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label. They shall be listed at the AIC ratings where installed on this project.

b. All materials and equipment specified herein shall conform with all applicable NEMA, ANSI and IEEE standards.

c. All materials and equipment specified herein and their installation methods shall conform to the latest published version of the National Electric Code, N.E.C..

C) SUBMITTALS

a. Submittal documents shall be submitted via E-mail in PDF format. All products for each spec section shall be included in a single PDF document including the cover sheet and index in one single document. submittals shall be indexed and identified as follows:

(1) Email subject line shall be “project name, EI&C submittal - submittal #, spec section# - description.”

(2) Cover sheet with:

(a) the project name and submittal #

(b) Contractor's and sub-contractor’s name, phone number, and email address.

(c) index sheet showing each product being submitted.

(3) PDF index tabs per the electrical specifications by section and paragraph or equipment name e.g. provide a minimum of one tab section for each piece of equipment in all of the PART 2 PRODUCT Sections 2.01 - 2.**.

(4) Label each equipment submittal sheet with equipment name and number. Indicate location where each item of equipment submitted will be used on the job. Use equipment numbers when available.

(5) Identify specific options and cross hatch out any information that is not a part of the specific information for the submitted component.

b. Submittals shall include the manufacturer's name, address, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, project specification and paragraph reference. Include other information necessary to establish contract compliance of each item proposed to furnish.

c. 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 comment.

d. After review by the ENGINEER, the CONTRACTOR shall submit the Shop Drawings of the service section to the utility company for approval prior to fabrication.

D) COORDINATION OF EQUIPMENT

a. It is the Contractor's responsibility to coordinate equipment information with the transfer switch manufacturer so that the correct type of equipment is 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 equipment will fit physically within the space allotted per the contract drawings.

E) ACCEPTABLE MANUFACTURERS (AUTOMATIC TRANSFER SWITCHES)

a. Acceptable manufacturers are.

(1) ONAN Corporation

(2) ASCO

(3) SQUARE D

(4) KOHLER

(5) CUTLER HAMMER/WESTINGHOUSE

(6) ZENITH

(7) RUSSELL

(8) Or Equal

b. The equipment of the manufacturer selected must fit within the space restrictions as shown on the plans.

F) O&M DATA

a. Provide O&M data for all transfer switch and related equipment in accordance to the general requirements in Section 16010.

2. PRODUCTS

A) GENERAL REQUIREMENTS

a. The transfer switches shall be equipped with three poles for normal and emergency service of 480 volts, 60 hertz, 3 phase. The transfer switches shall be rated **400** amperes.

b. The transfer switch shall be mechanically and electrically held and rated to 600 volts for all classes of load and continuous inductive duty.

c. The transfer switch shall conform to UL 1008 Revision 4 provisions for Withstand Current Ratings and Closing Ratings. The switch shall be rated for a minimum RMS symmetrical fault current (AIC rating) of

   i) 25,000 A for switches rated 400 amps and below,

a. The automatic transfer switch shall, <u>open transition</u> type with a minimum adjustable pause in neutral capability of 10 seconds, incorporating isolating switching unit mechanisms and overcurrent protection on the utility supply with number of poles as specified on the drawings.

b. The switch shall be double throw inherently interlocked mechanically and electrically to prevent supplying the load from both sources simultaneously. The operating current shall be obtained from the source to which the load is to be transferred. The transfer mechanism shall be of the double break design with solid silver cadmium surface contacts and individual heat resistant arc chambers.

c. Single break contacts will also be acceptable if arc barriers and magnetic blow out coils are used. The contacts shall be capable of carrying 20 times the continuous rating for interrupting current.

d. All contacts, coils, etc. shall be readily accessible for replacement from front of panel without major disassembly of associated parts.

e. The transfer switch shall have UL 1008 label and listing.

B) AUTOMATIC TRANSFER SWITCHES

1. CONTROLS HARDWARE

a. All wiring shall be numbered at each end with basic wiring numbering scheme.

b. All terminals shall be clearly labeled

c. All internal equipment shall be labeled

d. All external devices shall be clearly labeled

e. Provide nameplate on transfer switch as shown on the drawings

f. Provide transfer switch with solid state logic

g. Provide transfer switch with LED status annunciator showing graphic display of source availability and switch position.

2. CONTROLS FEATURES

a. Automatic transfer switches shall include the following accessories:

(1) Undervoltage Sensor: Adjustable solid state low voltage sensing relays (pick up at 85 to 98 percent of normal voltage - set at 98%; drop out at 75 to 100 percent - set at 90% of pickup setting). Provide for each phase.

(2) Time Delay Start and Stop on Drop Out: Solid state adjustable time delay on start (0 to 15 seconds). Set start delay for 15 seconds. Timer will send start signal to gen. set CP, where louver timer will allow 15 second delay for louvers to open prior to starting genset.

(3) Time Delay Stop: Solid state adjustable time delay (0 to 10 minutes) to allow generator cool down after normal power is restored and retransfer occurs. Set at 5 minutes.

(4) Time Delay Transfer & Retransfer: Solid state time delay relay adjustable 2 to 120 seconds for transfer to emergency and 0 to 30 minutes for retransfer to normal. Set at 5 minutes for retransfer to normal. Set at 5 seconds for transfer to emergency.

(5) With or Without Load Selector Switch: Switch to select exercise with or without load.

(6) Normal-Test Switch: Switch such that in the "Normal" mode the transfer switch will operate automatically and in the "Test" mode the generator will start for test purposes. This switch shall work in conjunction with the "With" or "Without" load switch. An extra contact block shall be provided on the normal-test switch for wiring to the Programmable Controller, if one is required.

(7) Exercise Clock: An exerciser clock shall be provided which shall be programmable to exercise the generator set. The exerciser shall be adjustable from 15 to 60 minutes once each week. The exercise shall be either with or without load. If power fails during the exercise cycle, the load shall automatically pick up.

(8) Programmed Transition: The load transfer control shall be capable of remaining in the neutral position for an adjustable time of .5 to 60 seconds when transferring from one line power source to the other to allow residual voltages to decay before application of the source.

(9) Provide the following dry contacts each with terminals for field connection, 2 amp rated at 120 VAC.

(a) Two separate normally open dry auxiliary contacts, one indicating transfer switch is in NORMAL position and one indicating switch is in EMERGENCY position,

(b) Four separate normally open dry contacts two indicating "commercial power / normal power" available and two indicating generator / emergency power available.

(c) Normally open dry contact indicating generator called to run.

(10) Position lights for normal and emergency position indication

(11) Two indication lights, one for emergency power available and one for normal power available

(12) Note: provide LED type lights for all indication lights.

2. EXECUTION

A) GENERAL

a. The transfer switch shall be delivered to the site ready for external connections to field equipment. Transfer switch shall be leveled and securely anchored to the floor and / or wall.

b. All assembly and wiring not completed by the manufacturer or Integrator, due to shipping sections, multiple suppliers, etc. shall be the responsibility of the Contractor.

B) TESTING

a. Automatic transfer switches shall be configured by the Contractor and field tested along with the control system and the generator per the requirements in this section and 16921

b. Testing and inspection of the automatic transfer switch shall include all components. .

c. After completion of initial testing, Contractor shall conduct subsequent testing for inspection by the Engineer. All control functions and all status and alarm monitoring and indication shall be demonstrated under simulated operating conditions.

C) INSTALLATION

a. The transfer switch equipment shall not be shipped to the site until a suitable environment is available for installation of the equipment. A suitable environment for the purposes of this contract for the automatic transfer switch shall be dry, covered and heated Prior to shipment of electrical equipment, the Contractor shall contact the Engineer for field verification of a suitable environment.

b. The transfer switch shall be installed in accordance with the installation drawings and instructions. Installation shall be performed by workers who are skilled and experienced in the installation of motor control equipment. It is the contractors responsibility to provide sufficient space for the equipment and size of equipment to fit within the space requirements and meet all code requirements.

D) WIRING

a. Refer to Section 16145-Wire and Cable Termination.

b. Separately bundle all signal and low voltage wiring from 120V and 480V wiring and maintain a minimum of 2 inches separation of conductors.

END OF SECTION

SECTION 16400

UTILITY POWER SERVICE & METERING

1. GENERAL

Description of Work:

a. Work consists of:

(1) Installation of new service 480Y/277V 3 phase 400 amps to the new pump station building.

(2) Installation of a temporary service and service pole panels and transformers for:

(a) 480Y/277V 3 phase 200 amp service to the existing pump station.

(b) 120/240V 1 phase 100 amp panel for temporary power and construction power.

(3) The removal of the existing service and temporary service to the existing pump station after the new pump station is complete.

B) SCHEDULING WORK WITH THE UTILITY COMPANY:

a. The Contractor shall be responsible for all scheduling and coordination with the utility company. The Contractor shall coordinate and schedule power outages, power service for operation and construction, and power service as may be required by the facility prior to Certificate of Occupancy.

b. The Owner will make all necessary applications for service with the utility. The Contractor shall notify the owner in writing of any obligations that the owner must fulfill for service to be started, installed, or modified.

C) CONTRACTOR/UTILITY INTERFACE RESPONSIBILITIES:

a. The requirements shown on the drawings for power service to the site is general in nature and the Contractor shall meet all of the serving utilities requirement to deliver a complete electric service.

b. During design contact was made with Seattle City Light Contact Mundall Engineering for name and contact information.

c. The contractor shall coordinate and provide all required work and equipment to provide service to the site as required by the serving utility.

d. UTILITY CHARGES

(1) All direct serving utility charges for the permanent service will be paid for by the Owner and shall not be included in the Contractor's bid price.

(2) The Contractor is required to coordinate work with the power utility and other utilities as necessary for installation of new service and service entrance requirements.

(3) Utility charges, including all costs associated with utility meter and/or transformer changes, for permanent service shall be paid directly by the Owner. Contractor is to submit Utility invoices for such work, without markup, to the Owner.

D) QUALITY ASSURANCE

a. Comply with all serving utility company standards and requirements.

E) STANDARDS AND CODES

a. Work involving service installation shall be done in accordance with the serving utility's standards and the National Electric Code.

b. Service equipment shall be listed and labeled by UL as "suitable for use as service equipment".

F) SUBMITTALS

a. In conformance with the submittal requirements of Section 16010, submit catalog data showing material information and conformance with specifications on the following:

b. Prior to submittal to the Engineer, the Contractor shall submit all equipment and construction details (such as size, mounting height, materials, location of equipment, etc.) to the serving utility for verification of compliance to the utility's requirements.

2. PRODUCTS

A) METER ENCLOSURE

a. Meter enclosure shall be as required to meet the requirements of the serving utility. Installation shall be per the utility requirements.

b. Contractor shall coordinate with Utility. on type of metering required and shall provide all labor and material necessary to meet Utility requirements.

c. Provide disconnect ahead of the meter if required by the Utility. Disconnect shall meet Utility standards.

B) C.T. ENCLOSURE

a. Utility metering CT enclosures shall meet all requirements of the serving Utility and shall be located as shown on the drawings.

C) LIGHTNING ARRESTOR:

a. Where lightning arrestors are shown on the oneline diagram provide an MOV type lightning/surge arrestor in combination with a surge capacitor rated for the service voltage to protect against overvoltage transients. Minimum 100KA rating for the surge arrestor. Delta lightning arresters, Inc. 600 series and CA603 capacitors or equal. Select proper components for the application as shown on the drawings.

3. EXECUTION

A) GROUND ELECTRODE SYSTEM

a. The grounded conductor and ground bus shall be connected to the grounding electrode system, via the grounding electrode conductor as indicated on system one-line diagram.

b. The system shall be as indicated in Article 250-81 of the National Electrical Code.

B) SERVICE COMPONENTS

a. Install all service components (service raceways, transformers, primary raceways, conductors, handholes, vaults, etc.) in accordance with the utility requirements, the NEC, and section 16145.

b. Provide service handholes and vaults as required by the serving utility even if not shown on the plans.

C) UTILITY REQUIREMENT VERIFICATION

a. The contractor shall coordinate and submit all equipment, materials, etc. related to the utility work to the serving utility to verify conformance to the Utility's requirements for service. The contractor shall also submit any plans for the installation of the primary and secondary service for approval by the Utility prior to excavation. Any discrepancy between the Utility requirements and the Contract documents shall be brought to the immediate attention of the Owner & Engineer.

b. Contractor shall obtain permit and obtain L&I inspection prior to connection of power.

END OF SECTION

SECTION 16500

LIGHTING

1. GENERAL

A) DESCRIPTION OF WORK

a. This section covers furnishing and installation of all light fixtures and lamps indicated on the drawings or specified herein.

B) STANDARDS AND CODES

a. All materials and equipment specified herein shall within the scope of UL Examination Services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.

b. All materials and equipment specified herein shall conform with all applicable NEMA, ANSI and IEEE standards.

c. All materials and equipment specified herein and their installation methods shall conform to the latest published version of the National Electric Code, N.E.C..

C) SUBMITTALS

a. Submit catalog data showing material information and conformance with specifications. The intended use of each item shall be indicated.

2. PRODUCTS

A) LIGHT FIXTURES

a. Fixture Schedule - Provide in accordance with Lighting Fixture Schedule & notes as shown on plans.

b. The fixture catalog numbers listed in the fixture schedule indicate manufacturer, fixture design, quality of design and manufacture, appearance, features and options required. Lighting fixtures specified will be the basis for comparison in the consideration of fixtures of other manufacturers. Fixtures of lesser quality shall not be considered equivalent.

c. Contractor shall investigate ceiling construction and other mounting locations and supply fixtures designed for the application.

d. Contractor shall investigate possible interferences of equipment, hatches, overhead cranes, etc. and supply fixtures (size and profile) that will not interfere.

e. All fixture component parts shall be manufactured and/or assembled at the manufacturing plant for shipment. The shipment from the fixture manufacturer shall include integrally mounted and/or remote mounted ballasts where ballasts are required for the proper operation of the fixture lamps.

B) HARDWARE

a. The Contractor shall provide any necessary hardware for mounting fixtures. The mounting hardware shall be made of materials suitable for the environment installed. Provide materials made from aluminum, non-metallic, or 316 stainless steel in outdoor, damp, or corrosive areas.

C) BALLASTS

a. Ballasts shall be of the high power factor type. All ballasts shall be rated for 0 degree C operation and be equipped with automatic resetting protective devices in accordance with UL requirements.

b. Ballasts shall be energy efficient GE Maxi-Miser II ballasts or equal.

D) LAMPS

a. Provide all lamps as specified. Refer to the Lighting Fixture Schedule.

b. Provide all fixtures with an LED lamps. Lamps shall be DLC qualified. Manufactured by LEDIZ, Greencreative, Sylvania or equal. Lamps shall be provided for all lighting fixtures

E) SPECIAL ACCESSORIES

a. Provide accessories such as junction boxes, plastic frames, stem, hangers, canopies, couplings, cords, toggle bolts, etc., necessary to mount fixture in a proper and approved method.

3. EXECUTION

A) RACEWAY & WIRE

a. For all lights, switches, and other related devices of the lighting system, provide all necessary raceway and wire per section 16110, 16120 or 16145 for a complete installation.

B) FIXTURE MOUNTING

a. The fixture supplier shall provide all necessary hanging or mounting devices for all fixtures and shall be responsible for checking the type needed for various ceiling conditions.

b. The Contractor shall see that all lighting fixtures designed to be installed throughout the project shall be of the correct size and design to properly suit the requirements of each area prior to ordering fixtures.

c. Contractor shall install fixtures to avoid access hatches, sky lights, rails, hoists, mechanical equipment, etc.

d. Any additional hardware needed for installation of fixtures shall be provided by the Contractor; including poles, clamps, brackets, screws, bolts, etc.

e. Fixtures and other equipment installed in hazardous areas shall be rated for the environment. Provide fittings and seals per NEC.

f. Pendant mounted lighting fixtures shall be supported by a flexible fixture hanger CROUSE-HINDS Type "AI" and shall have locking couplings, CROUSE-HINDS Type "COUP".

g. Where fixtures are indicated for installation on low-density ceiling material, mount on 1 1/2" ceiling spacers unless UL approved for mounting directly to ceiling material.

h. Properly support and align fixtures and provide all necessary steel shapes for support of the fixtures. Coordinate complete fixture installation with the facility construction. Clean and mount all lighting fixtures with new lamps immediately prior to final inspection.

i. Square and rectangular fixtures shall be mounted with sides parallel to building lines and parallel with ceiling lines.

j. Install fixtures as recommended by the manufacturer or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection or angular jointing of fixtures installed in continuous rows.

END OF SECTION

SEE LIGHTING AND FIXTURE SCHEDULE & NOTES ON THE DRAWINGS

SECTION 16921
INSTRUMENTATION AND CONTROLS

1. GENERAL

A) DESCRIPTION OF WORK

a. This spec section is intended to specify the components of the instrumentation and control system including: control panel(s) and the general requirements for the construction and arrangement of the associated equipment and field instrumentation.

b. Work and materials specified in this section include:

(1) PLC control cabinet(s) (MCP), I/O, and associated equipment and instrumentation.

(2) Power equipment (starters, VFDs) - Motor Controls

(3) Motor starters and power distribution equipment

(4) Field Instrumentation, installation and calibration requirements

(5) Shop and field testing, and calibration of power & control system components and equipment.

B) SYSTEM DESCRIPTION

a. Provide Control panels for all equipment control, monitoring and alarming.

b. Provide power equipment in power panels (PP1 and PP2) with VFDs, motor starters and controls, etc.

c. Provide field instrumentation and control devices and installation details

C) SYSTEM INTEGRATOR

a. The System Integrator shall be responsible for the final design and assembly of the instrumentation and control system and control panels.

b. All programming of the PLC and operator interface shall be by the Owner.

c. The System Integrator shall be responsible for the final design and assembly of the entire I&C system. The system shall be designed to provide the control capabilities and functions indicated and implied by the plans and these specifications and to provide trouble-free operation with minimum maintenance. The system shall readily enable manual operation of any and all functions in the event of failure of any one component.

d. Only pre-approved integrators shall provide equipment under this contract

e. The following are pre-approved System Integrators for this project

(1) Quality Controls - Lynwood, Washington

(2) Technical Systems, Inc. - Lynnwood, Washington

(3) Taurus Controls, Kent, Washington

(4) Evolution Controls – Everett, Washington

(5) Superior Custom Controls – Seattle, Washington

f. Other alternate System Integrators may obtain pre-approval if they meet the following minimum requirements.

(1) Factory trained and certified for the controller provided on this project, or have a minimum of 3 years of field experience and at least four applicable projects with configuration and installation of this equipment. Integrator shall provide resumes for individuals performing the work showing successful completion of factory training and field experience.

(2) Factory trained and certified for the drives provided on this project, Integrator shall provide resumes for individuals performing the work showing successful completion of factory training.

(3) Integrator shall provide UL 508A certification for control panels.

(4) Field service technicians shall have a minimum of 2 years of field experience with the components, controllers, and instruments provided on this project.

(5) Integrators shop shall be within 50 miles of the project site

D) STANDARDS AND CODES

a. All equipment and materials shall conform to the latest revised editions of applicable standards published by the following organizations:

(1) American National Standards Institute (ANSI).

(2) Institute of Electrical and Electronic Engineers (IEEE).

(3) National Electrical Manufacturer’s Association (NEMA)

(4) Underwriters' Laboratories (U/L).

(5) Instrument Society of America (ISA).

b. All electrical equipment and 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.

c. All materials and equipment specified herein shall within the scope of UL examination services, be approved by the Underwriter's Laboratories for the purpose for which they are used and shall bear the UL label.

d. All control panels shall bear a label by UL or by an approved testing authority for the completed assembled panel.

E) SHOP DRAWINGS

a. The System Integrator shall develop any shop drawings required for design, fabrication, assembly and installation of the power and control panels. Shop drawings shall include all drawings required in manufacture of specialized components and for assembly and installation of them. Shop drawings shall include detailed "end-to-end" control wiring diagrams showing all interface of field equipment and instrumentation. In addition the following drawings shall be provided:

b. CONTROL CABINET LAYOUT DRAWINGS

(1) The System Integrator shall develop shop drawings for the control cabinets and wiring and terminals within the control cabinets to show all details of the control system. Drawings shall include scaled drawings of both interior and exterior elevation views. All components shall be identified by both the nameplate information and also the component number related to the bill of materials.

c. EQUIPMENT AND INSTRUMENT WIRING DIAGRAMS (LOOP DWGS)

(1) The System Integrator shall provide individual wiring diagrams (one drawing) for each field instrument and for each controlled motor load. All wiring interface for each instrument or equipment shall be shown on a single drawing* and the drawing shall be titled with the equipment or instrument name and number. Each drawing shall include field devices, PLC I/O and motor control, etc. associated with that instrument or equipment Include all terminals – terminal numbers, wirenumbers (both internal and field), PLC I/O and memory address, and equipment TAG number. See example drawings

** for instruments of the same type - if space allows then more than one instrument of the same exact type may be shown on a single drawing. This exception applies for instruments only, not for equipment.*

a. CARD DRAWINGS

(1) The System Integrator shall provide the information for each input and each output of the PLC on "PLC Card drawings". All details of each card must be shown on a single drawing – one I/O card per drawing*.. Example drawings are included at the end of this section. Each I/O point shall be designated with the memory address, point id tag number, point description and wiring diagram reference drawing number

** cards of the same type – if space allows, then more than one card of the same exact type may be shown on a single drawing.*

TERMINAL ARRANGEMENT DRAWINGS

Provide terminal layout drawings that show the layout of all terminals in the cabinet.

a. Shop drawings shall be drawn in AutoCAD 2008 or earlier version and include the following:

(1) Technical data sheets for all components with the complete part number of the component clearly designated with all required options.

(2) Arrangement drawings of all cabinet front-mounted and internal-mounted instruments, switches, devices, and equipment indicated. Show all panel mounting details required. Include outer dimensions of all panels on the drawing. Deviations from approved arrangements require resubmittal and approval prior to installation.

(3) Arrangement drawings shall be drawn to scale using standard Architectural or Engineering scales.

(4) Shop drawings shall be provided on 11" X 17". Shop drawings shall include specific product detail such as rating, size, and number of contacts, etc. Wiring diagrams shall be included for all components in the system including control equipment supplied with mechanical devices.

(5) For shop drawing packages provide the drawings in a separate 11" X 17" binder with an index for the drawings at the front.

b. Installation details shall include the size, number, type and location of interconnecting wiring and conduit, installation of cabinets and enclosures, installation of sensors, instruments, limit switches, and other installation requirements. Shop drawings shall be submitted to Engineer for review and approval.

B) SUBMITTALS

SUBMITTAL REQUIREMENTS

Submittal documents shall be submitted via E-mail in PDF format.

I&C submittals shall be provided in two complete separate documents one with all product data and a second with all shop drawings as follows:

All products shall be included in a single PDF document including the cover sheet and index and bill of materials (BOM) in one single document. – Index the PDF document to show each individual product in the index column.

Shop drawings shall be included in a single PDF document including the cover sheet and index in one single document.

Submittals shall be indexed and identified as follows:

Email subject line shall be "*project name*, EI&C submittal *submittal #, spec section# - description."*

Cover sheet with:

the project name and submittal #

Contractor's and sub-contractor's name, phone number, and email address.

BOM bill of materials showing each product being submitted.

List of deviations from specified components

PDF index tabs per the electrical specifications by section and paragraph or equipment name e.g. provide a minimum of one tab section for each piece of equipment in all of the PART 2 PRODUCT Sections 2.01 - 2.**.

Per the general submittal requirements in other sections of this specification and the following. The System Integrator shall develop and shall submit to the Engineer the following project data:

A detailed project schedule relating specifically to I&C - showing submittals, review time, long lead equipment, panel fabrication, expected site delivery date - startup, etc. highlight any anticipated critical path tasks. Provide a copy with the submittal and e-mail in PDF.

All shop drawings: (provide an electronic copy, in AutoCAD of all shop drawings on CD ROM to the Engineer with the submittals, revised submittals, and with final as-built drawings).

Cut sheets for all products with a BOM - Bill of materials showing quantity, Manufacturer, catalog number, and the supplier name and phone number and relevant spec. paragraph number. Number each item in the bill of materials and relate the bill of materials to the submitted product index.

I/O checklist that verifies that all control and status/indication points in the control panels both implemented and spare have been tested. One copy of the I/O Checklist shall be submitted for the start of the Factory Test. One copy of the I/O Checklist shall be submitted prior to the Control system startup. The PLC Card drawings shall be used for this purpose.

Provide reference numbering on all cut sheets to relate them to the bill of materials. Provide same reference numbering by the equipment shown on the shop drawings.

Provide a listing of all spare parts to be provided.

NOTE; submittals received by the Engineer that are incomplete or not organized or do not conform to the specifications or do not have complete drawings as specified shall REJECTED and returned without review. Contractor should anticipate that submittals and re-submittals can take up to 3 weeks from the date mailed to the date returned with review comments if using standard submittal procedures.

A) COORDINATION WITH OTHER EQUIPMENT

a. The System Integrator shall be responsible for obtaining all necessary information/product data (wiring diagrams, load data, etc.) for other equipment and instrumentation used in the project that requires integration into the power and control system – even for equipment and instrumentation outside the System Integrator's scope of supply. This may include, but is not limited to (standby generator, ATS, flow transmitters and other instrumentation, control valves, motor data, etc.)

b. System wiring diagrams shall include information from other equipment.

c. See PART 4 of this specification for additional requirements

B) NAMEPLATES

a. Nameplates shall be provided on all electrical devices – (equipment, instruments, boxes, etc.)

b. Nameplates shall also be provided on all electrical panel interior and exterior equipment (including but not limited to: relays, I/O cards, circuit breakers, power supplies, terminals, contactors, switches, indicating lights, buttons, meters, and other devices.)

Equipment nameplates shall have both the equipment name and number and equipment circuit number (if applicable).

INSTRUMENT NAMEPLATES: Provide nameplates for all instruments with instrument name, number, and the ckt breaker, or fuse location for the power source. – for nameplates that cannot be attached to the instrument provide a stainless steel cable ring to attach it to the instrument.

a. Nameplates shall be made of 1/16" thick machine engraved laminated phenolic having black letters not less than 3/16" high on white background or as shown on the drawings or other sections of the specifications. Nameplates on the interior of panels shall be White Polyester with printed thermal transfer lettering and permanent pressure sensitive acrylic; TYTON 822 or approved equal. All nameplates shall include the equipment name and number (and function, if applicable).

b. Relays shall be provided with 2 nameplates, one on the backpan by the relay base and one on the face of the relay.

c. Provide warning nameplates on all panels and equipment which contain multiple power sources. Provide nameplates describing locations of power sources and disconnects. Provide any other warning or information nameplates as required by NEC or UL.

d. Nameplates shall be secured to equipment with stainless steel screws/fasteners. Epoxy glue or other quality adhesive may be used where fasteners are not practical if first approved by the Engineer.

2. PRODUCTS

A) GENERAL

1. DESIGN AND ASSEMBLY

a. All equipment and materials utilized in the system shall be the products of reputable, experienced 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.

b. 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 of operation of motor-driven pumps and equipment.

c. All equipment shall be of modular design to facilitate interchangeability of parts and to assure ease of servicing. All equipment, where practical, shall be of solid state, integrated circuit design.

d. The system shall be completely assembled in the shop by the System Integrator. All components and equipment shall be prewired to the maximum extent possible.

e. All components, including both internally and face-mounted instruments and devices, shall be clearly identified with phenolic nameplates of black background with white letters. Nameplates on the interior of panels shall be White Polyester with printed thermal transfer lettering and permanent pressure sensitive acrylic; TYTON 822 or approved equal.

2. INTERCONNECTING WIRING/TERMINALS

a. All conductors shall be stranded wire with thermoplastic insulation and shall be cabled to groups and supported so as to prevent breaking and to present an orderly arrangement and neat appearance. All outgoing wiring shall be terminated on a marked terminal strip capable of connection of at least 2 No. 14 wires and all terminal connections shall be numbered throughout the system.

TERMINAL NUMBERING –

All field terminals shall have UNIQUE TERMINAL NUMBERS. This also includes NEUTRAL and LINE terminals shall be individually identified. (example NU1, NU2 ..etc. for UPS neutrals N1, N2 etc for normal power neutral terminals.

Terminal numbers and wire numbers shall relate to the equipment or component number or drawing number.

a. In general: all field control wiring shall be #14 AWG. Internal wiring may be smaller #16 or #18 is acceptable as long as it is sized for the load and circuit protection. PLC I/O wiring between the PLC cards and the terminal strips shall be pre manufactured bundled cables wire size shall be #18 - #22.

b. WIREWAYS

(1) Provide wire ways as necessary in the enclosure to contain all internal wiring and all field wiring that exists on this contract with consideration given to future space and the future wiring. Size wireways such that there is ample room for the

numbers of wires that will be wired to the terminals or terminal space in the cabinet plus room for an additional 30% future wire.

(2) Provide corner wireways in the cabinet corners or as shown on the drawings

(3) Low voltage DC control and signal conductors shall be bundled separately from alternating current circuits. Separate raceways and wire gutters shall be dedicated for AC and DC wiring, and labeled as such on the shop drawings. Wiring may cross at right angles if necessary. Special caution shall be used for PLC I/O card wiring and field terminations to accommodate the separation of AC and DC circuits. Intrinsically safe wiring shall be physically separated from non intrinsically safe wiring.

(4) Internal wiring shall be in separate wireways from the field wiring.

c. All wiring and tubing crossing hinges shall be installed in a manner to prevent chafing. Bundles of similar conductors shall be clamped securely to the door and to the panel, and the bundles shall run parallel to the hinge for at least 12 inches. Spiral nylon cable wrap shall be provided in the hinge section of the bundle to fully protect the conductors or tubing against chafing.

B) PROGRAMMABLE CONTROL EQUIPMENT

1. PROGRAMMABLE LOGIC CONTROLLER (PLC)

a. The PLC shall be Allen-Bradley CompactLogix. Selection shall be based on the number of I/O required.

b. Provide PLC processors with on board Ethernet communications.

c. Provide all PLCs with EEPROMS

d. PLC rack w/ spare slots – if applicable

e. 24VDC digital input cards

f. 24VDC digital output cards. All digital outputs shall interface with the output relay terminals

g. Analog input cards with individually isolated points

h. Analog output cards with individually isolated points

i. Note combination cards are not allowed except with special permission from the Engineer

j. Provide power supplies as required and recommended by the manufacturer.

k. Spare and empty slots in the PLC rack shall be covered with a blank slot filler.

l. Provide all necessary power supplies as required and recommended by the manufacturer.

m. Provide isolated fused circuit for power to PLC

n. Spare and empty slots in the PLC rack shall be covered with a blank slot filler.

2. ADDITIONAL I/O

a. System Integrator shall provide all I/O necessary for the operations of the equipment and instrumentation for the project and as shown on the wire diagrams.

3. SPARE AND FUTURE I/O

a. INSTALLED SPARE: Provide all necessary analog and digital I/O for the project plus 10% installed spare, (round up to the nearest whole number) in each cabinet,. Provide terminals for all installed PLC I/O cards (including spares) to match the number of points in the card. For all spare I/O provide interface wiring to terminals.

b. Provide 1 spare fused disconnect for every 4 spare digital input terminals.

c. Spare digital outputs shall all be provided with interposing relays with one form C output wired to two terminals for a normally open contact interface.

d. For each spare analog input provide one fused, and two non fused wired for a loop powered instrument input. Provide one shield ground terminal for every two spare analog inputs.

e. FUTURE: Provide spare space to the right of the PLC for at least five additional I/O cards in each PLC cabinet. Provide spare din rail for the additional terminals associated with the additional I/O cards (minimum of 24" for digital and 24" for analog terminals) and also account for the additional room in the wireways for the future wire.

C) COMMUNICATIONS EQUIPMENT

1. ETHERNET COMMUNICATION MODULE

a. Provide Ethernet communications on the PLC processor for communications.

2. ETHERNET COMMUNICATIONS SWITCH

(1) All Ethernet switches used for this project shall be made by the same manufacturer.

(2) Provide an Ethernet switch with ports as required as shown on the drawings plus 1 spare port. Ethernet switches shall be din rail mountable. The switch ports shall be configurable for either 10 or 100 base T. Siemens, Allen-Bradley, Hirschmann or N-Tron, or equal. Provide mounting and power circuits as required for the equipment.

D) PROGRAMMING OF PROGRAMMABLE CONTROLLER

1. GENERAL

a. The programmable controller equipment shall be programmed by others and the programming cost shall not be included in the bid.

EQUIPMENT ENCLOSURES

1. CABINET SIZE

a. Sizes of enclosures for the power and control cabinets shall be chosen by the System Integrator to provide ample space for the installed components and still fit within the given space in the structure.

b. The enclosures minimum size shall be as shown on the drawings. With Engineer's approval, the Integrator shall upsize the cabinets if necessary to fit in the components.

2. CONTROL CABINETS

a. Indoor Control cabinets shall be NEMA 12 – powder coated steel construction.

b. Control cabinets in corrosive or damp areas shall be stainless steel or non- metallic.

c. Cabinets shall be hinged with stainless steel pins.

d. Cabinets shall be provided with a stainless steel 3 point latch.

e. Provide all control cabinets with a data pocket and insert the cabinet drawings in the pocket when shipped to the site.

f. Enclosure shall be manufactured by Hoffman Products, Inc. or approved equal.

3. ENCLOSURE DOOR LATCHES

a. Door latches on all enclosures shall be fast operating type 3-point latch stainless steel lockable door handle.

b. Small boxes and control stations shall have 2 stainless steel screw driver or hand operated latches.

4. WIREWAYS

a. Provide molded plastic wireways, slotted for wire connections for all wiring in the panels. They shall be complete with covers. Wireways shall be manufactured by Panduit or Taylor, or approved equal.

B) TERMINALS

1. GENERAL

a. Provide terminals blocks arranged per the examples drawings and as described in this specification.

PLC card – I/O terminal blocks shall be grouped together to match the terminal arrangement of the PLC card that they are connected to.

TERMINAL NUMBERING –

Provide unique terminal numbers for all field wired terminals.

Terminal numbers and wire numbers shall relate to the shop drawing number.

Provide clear references on all wires that connect between drawings or are shown on more than one drawing.

Provide terminals for all wire connections to field wiring and internal power distribution. For all terminals (including line voltage and neutral terminals) that are used for wiring out to field devices provide unique terminal numbers.

Provide spare din rail space and spare terminals as indicated by the drawings or these specifications.

For all energized circuits (power and control) powered from the panel and extend outside of the panel provide an individual fused terminal with appropriate fast blow fuse (1/2 amp for PLC inputs) and “blown fuse” indicator light for each circuit and unique terminal number.

For all signal circuits that extend outside of the panel provide an individual fused terminal with appropriate fusing and integral blown fuse indication. All 4 to 20 mA circuits shall be individually fused with a 1/16 amp fast blow fuse; and blown fuse indicator.

For all energized circuits powered outside of the panel which extend into the panel, provide a disconnecting terminal to isolate each individual circuit.

Provide fusing of all DC circuits with appropriately sized fuses and blown fuse indicators.

Analog loops that are 24 VDC powered shall have a knife switch to disable the loop.

Connections shall have compression terminals capable of terminating 2 #14 AWG stranded wires. Terminals shall be DIN rail strip mounted Provide number strips for terminal blocks that are referenced by the wire marker. Provide bridge bars for jumpering between terminal blocks. Provide end clamps to separate and terminate terminal block groups. Provide end covers for groups of terminal blocks in sets to match the number points associated with individual I/O cards in the PLC rack.

Provide Separation Plates on each side of terminals that are at a different potential or polarity than surrounding terminals.

Provide clear plastic DIN rail mounted nametag stanchions for each block of terminations. Each nametag shall hold a preprinted label designating the PLC rack and PLC card (slot) that terminates to that set of terminals.

Terminals shall be mounted such that there is a minimum of 2 inches of clear space on both sides of the terminal (between the terminals and the wireway); for ease of wiring and so that the entire wire tag will be visible outside the wireway.

Mount all terminals strips on 2" standoffs from backpan.

Provide wired terminals to match the number of points supplied on each I/O card in a cabinet.

GENERAL PURPOSE AND DIGITAL INPUT TERMINALS

Terminal Blocks for general purpose and digital input terminations shall be Phoenix Contact UK 5, or equal. Provide UKK5 Double Hi, or equal, if space is limited.

ANALOG INPUT TERMINALS

Terminal Blocks for use in analog input terminations shall be knife disconnect type, Phoenix UK 5-MTK , or equal.

Provide one ground terminal for every two analog inputs for grounding the shield.

Provide a fused terminal with a ¼ amp fuse and blown fuse indicator for all analog inputs for loop power.

ANALOG OUTPUT TERMINALS

UKK 5 Terminal blocks for analog outputs shall be fused, double hi with a separate ground terminal, or equal.

DIGITAL OUTPUT RELAY TERMINALS

Provide interface/interposing relays for all digital outputs that extend out of the control panel and for all spare and future digital outputs. Relays shall be individual form C relays, or equal. Interface to digital output cards or relays as required to interface I/O module to DIN rail mounted relays, or equal.

Relay output cards are not to be used unless specifically allowed by the Engineer. All digital outputs shall interface with individual output relays. Panel mounted devices may be directly powered by the output card if approved by the Engineer.

Provide relays to match the number of points supplied on each digital output card in a cabinet.

Provide two descriptive labels for all relays. – One label on the backpan and one label on the relay.

FUSED TERMINALS

Fuse terminal blocks shall be hinged disconnect level type with "blown fuse" indicators. PHOENIX CONTACT UK 5 HESI series, or equal

TEST AND CALIBRATION

Provide 1 set for each Cabinet supplied plus 1 spare set consisting of:

Short Circuit Plug, 1 pair of Reducing Plugs, 1 pair of Test Adapters.

OPERATOR INTERFACE DEVICES

All operator interface devices mounted on the panel front shall be rated for the environment in which they will be located. In general, devices mounted on indoor panels shall be NEMA 13 rated. Operator devices mounted outdoors, or in wet or corrosive environments shall be NEMA 4X rated.

SELECTOR SWITCHES

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 800T, 800H, GE CR104P, Square D Type K or approved equal.

PUSH BUTTONS

Push buttons and illuminated push buttons shall be for use on 120 volt control circuits. and shall have continuous current rating of 10 amperes both inductive and resistive. Pushbuttons for "emergency" "help" applications shall have maintained contacts and red mushroom head operators. Allen Bradley Bulletin 800T, 800H or approved equal.

INDICATING LIGHTS

Indicating lights shall be push-to-test LED type. Illuminated pushbutton type with the pushbutton wired for the push-to-test function required. Appropriate lens caps shall be provided as shown..

OPERATOR INTERFACE

Provide an operator interface. provide a minimum 10” inch color graphic display and resistive touch screen. Interface shall be capable of color graphic displays. Software shall be RS View Studio Machine. Provide with Ethernet communications module. Operator Interface shall be Allen-Bradley panelview plus 1000, Maple Systems, or equal.

Provide all necessary software and hardware for a complete system.

Programming of the operator interface shall be done by others.

CABINET POWER DISTRIBUTION

CONTROL PANEL CIRCUIT BREAKERS

Control panel circuit breakers shall be thermal-magnetic type, supplementary overcurrent devices. Circuit breakers shall be snap mountable on rails. Circuit breakers shall be sized for actual circuit load. or as shown on the drawings.

Provide 2 spare installed 5amp circuit breakers or the number of spares shown on the drawings, whichever is greater. Wire breakers out to terminals and provide number of spare neutral terminals to match number of hot terminals.

Provide 2 spare "hot" terminals wired to the output of each spare breaker and 3 spare neutral terminals wired to the appropriate neutral.

Control panel circuit breakers shall be Allen-Bradley 1492-CB, or equal.

In all control panels, provide a laminated drawing of the panel power distribution circuit breakers for referencing all circuit breakers in the panel.

GROUNDING

Provide 3 spare ground terminals in each cabinet

Provide a ground bus in each cabinet – minimum 6" long with screw terminals for grounding equipment and instrumentation.

FUSES

Provide, fuse pullers; (one for each type of fuse), for removal of fuses.

Provide blown fuse indicators on <u>all fuses</u>.

POWER SUPPLIES

Power supplies shall be switching type, voltage, & sized to be able to supply the demand. Units shall be closed frame DIN rail type and have overvoltage and overcurrent protection. Units shall have LED power on light and 2 sets of output terminals. Power supplies shall be sized for the load plus an additional 30% IDEC, Power Supply or equal.

Provide one fused and one non fused terminal for all DC circuits that extend outside the cabinet. Provide spare DC terminals for a minimum of 2 additional DC circuits or 10% whichever is the greater amount.

24VDC UNINTERRUPTIBLE POWER SUPPLY (UPS)

24VDC uninterruptible power supply (UPS) shall be a continuously on-line. Unit shall be 24VDC and maintain on battery backup for a minimum of 10 minutes. Unit shall be din rail mounted wired to control system power. The UPS capacity/rating shall be chosen by the System Integrator for the load being served plus 20%. .

PULS, Allen-Bradley 1606.XLS series, size chosen for the application or equal.

Provide UPS alarm module and provide all necessary wiring and relays for connection to the UPS to provide 2 normally closed contacts which open upon loss of power for the PLC digital inputs for: a) loss of input power to the UPS and b) for a battery alarm.

Provide labeling to differentiate UPS power circuits vs. non UPS powered circuits by adding a "U" suffix on the terminal name.

Provide 2 spare installed 5amp UPS circuit breakers or the number of spares shown on the drawings, whichever is greater.

Provide 3 spare "hot" terminals wired to the output of each spare UPS breaker and the same number of spare neutral terminals wired to the appropriate neutral.

RELAYS

RELAY LABELS

Provide two labels for all relays one label on the backpan and one label on the front surface of the relay.

RELAYS FOR GENERAL PURPOSE

Relays for general purpose shall have appropriate coil voltage for the application, contacts (amp and voltage) shall be rated for the application, minimum 2 amps. All relays shall have an integral indicating light to show if there is coil voltage present. They shall have pin/blade base and matching socket. Units shall be Allen-Bradley 700 type HA, HB, or equal.

Appropriate relay (coil voltage and contact load ratings) shall be selected based on application from the control wiring diagrams and load served.

TIME DELAY RELAYS

Time delay relays shall be multi-function, multi-range with plug-in base ,pin style terminations timing and timed out LED indicators, and calibrated scales. Relays shall have minimum 0.5 seconds to 60 minutes, 8 selectable timing ranges, 5 amp contacts. Select coil voltage for the application. Minimum accuracy requirements (plus or minus) shall be as follows: 1) Repeat accuracy 1/2% 2) Timing change over full voltage range 1/2% change over full temperature range 2% 3) Scale tolerance 5%. Allen-Bradley Bulletin 700 type HR series; or equal.

DIGITAL OUTPUT RELAYS

All digital outputs shall be provided with interposing relays wired out to terminals - including spares. Relays shall be group mounted with connecting cable to the PLC output card. Output relays can be single pole, N.O. or N.C. for the application – all Spare DO relays shall be form C with the N.O. contact wired to terminals.

MOTOR STARTERS / VFDS

Motor starter units shall be of the combination type with components as indicated on the drawings. Magnetic contactors shall be heavy duty IEC or NEMA rated, All contactors shall be provided with two field convertible auxiliary contacts. Motor starters and associated equipment shall be provided to match or exceed the load being served.

If IEC contactors are used, then the amp rating of the contactor shall be a minimum of 1.25 times the amp rating of the motor.

Provide interface options for control, monitoring, and alarming as shown on the drawings and the wire diagrams. Manufacturer shall select the size and rating as required for the application.

OVERLOAD RELAYS

Overload relays on starters shall be adjustable, solid state type with a minimum adjustment range of 3 to 1. Overload relays shall have selector for either auto or manual reset. . Overload Relays shall monitor all energized conductors and shall trip on phase fail and ground fault. A Separate N.O. overload contact shall be provided in addition to standard N.C. overload contact. Overload relay shall be provided with a circuit test button which shall simulate an overload trip, trip indication, and reset pushbutton. Overload which trip on phase/power fail shall automatically reset upon normal power restoration. - Siemens 3RB12, Allen-Bradley E-1 or equal.

Provide interface options for control, monitoring, and alarming as shown on the drawings and the wire diagrams. Manufacturer shall select the size and rating as required for the application.

CONTROL POWER TRANSFORMERS

Each of the power panels. Shall be equipped with its own individual control circuit transformer, 120 VAC secondary with primary and secondary fuses and blown fuse indicators. The transformer shall be sized to accommodate the contactor(s) and all connected control circuit loads. The transformer size shall also accommodate any devices connected or shown on the drawings (both existing and future) as being served by the control circuit transformer.

VFD control wiring shall be source wiring – control power shall be from the VFD source output. – typically 24VDC source output from the VFD

TRANSIENT SUPPRESSORS

Provide all contactor coils with transient suppressors to limit the high voltage transients produced when power is removed from the coil. CUTLER HAMMER - C320AS1 or equal.

VARIABLE FREQUENCY DRIVES (VFD)

VFDs shall be Allen-Bradley Power flex with full function HIM module mounted on the outer door or as shown on the drawings– VFD manufacturer shall select the size and rating as required for the application. Provide interface options for control, monitoring, and alarming as shown on the drawings and the wire diagrams. – Allen Bradley, Siemens, Schneider Electric, or equal.

Provide DC bus chokes and 3% line and load reactors on all VFDs

Provide with Ethernet communications.

Provide control features as shown on the plans.

Provide VFD control wiring for SOURCE control selection – SINKING inputs are not allowed.

For VFDs furnished with fans – provide controls or thermostats so that the fans do not operate unless the equipment is running or the temperature is high.

Provide VFDs with the following:

HOA switch and speed pot – in HAND speed will be controlled by the speed pot, In AUTO the VFD speed will be controlled from a remote 4-20mA input.

Provide a programmable VFD input such that (with the switch in AUTO) when a remote dry contact connected to the input closes the VFD will start and operate at a pre set speed.

Configure VFDs so that any “bad power” (line side) fault will automatically reset when normal power returns and the VFD will automatically restart if called.

Provide source power for control of VFD directly from the VFD or from a dedicated CPT for each individual VFD. Configure such that for the Drive to operate in HAND requires only the power source to the VFD.

Provide relays as necessary for run, fail and other contacts for input to the PLC, indicator lights, louver/fan/heater controls etc.

Configure the line side “faults” to maximum so that only major line side issues will shut down the VFD. Turn off any line side faults that are not required for protection of the VFD. Configure so that once line side faults clear and normal power returns the VFD will automatically reset and resume operation.

Configure VFD for operation on both generator power and utility power so that the difference in line side power from the two sources will not fault the VFD.

SERVICES OF MANUFACTURER

General: An authorized service representative of the manufacturer shall be present at the Site for two 1/4 Days to furnish the services listed below. For the purpose of this paragraph, a 1/4 Day is defined as an 2 hour period excluding travel time.

Inspection, Startup, Field Adjustment: The authorized service representative shall supervise the following and certify the equipment and controls have been properly installed, aligned, and readied for operation.

Installation of the equipment

Inspection, checking, and adjusting the equipment

Startup and field testing for proper operation

Performing field adjustments such that the equipment installation and operation comply with requirements.

Instruction of OWNER's Personnel: The authorized representative shall instruct the OWNER's personnel in the operation and maintenance and configuration of the equipment, including step by step troubleshooting with test equipment. Instruction shall be specific to the equipment models provided. Training shall be scheduled a minimum of 3 weeks in advance of the first session. Training session shall be 1 hour minimum. Proposed training materials shall be submitted for review, and comments shall be incorporated. Training materials shall remain with the trainees. The OWNER may videotape the training for later use with the OWNER's personnel.

CIRCUIT BREAKERS

Circuit breakers shall be molded case thermal-magnetic type, or where allowed by code may be Magnetic Only type with adjustable trip. Circuit breakers other than those mounted in the panelboard shall be capable of being padlocked in the open position. 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^{O}C. Molded case circuit breakers shall be trip-free. Each breaker shall have separate trip indication independent of the ON or OFF positions.

Breakers shall have lugs UL listed for both copper and aluminum.

Breakers shall have the interrupting rating and trip rating indicated on the drawings.

Provide service entrance rated breakers if required for the application by NEC.

Provide interface options for control, monitoring, and alarming as shown on the drawings and the wire diagrams. Manufacturer shall select the size and rating as required for the application.

DRY TYPE TRANSFORMERS

Provide dry type transformers in accordance to applicable requirements of Section 16145 or 16460.

Where the one-line diagram calls out for isolation transformers; provide noise suppresser isolation transformers, Square D/Topaz Class 7610 or equal.

SURGE ARRESTORS

Provide Surge arrestors , with indicators, where shown on the one-line diagrams to protect against overvoltage transients. JOSLYN J9200 series with protective capacitor GE model 9L18 or equal. Select proper components for the application as shown on the drawings.

WIRE MARKERS:

Field installed wire markers shall be T&B, SHRINK-KON HVM or approved equal.

SPARE PARTS

In addition to spare parts mentioned elsewhere in this section, the Contractor shall supply the following spare parts for use by the Owner: All spare parts shall be shipped with the equipment.

Qty 1 Relay of each type used.

Qty 2 lamps of each type used.

Qty 200% spare fuses (two spare fuses for each fuse supplied).

EXECUTION

INSTALLATION

GENERAL

The instrumentation and control system shall be installed, in accordance with the contract drawings, installation details, and also instructions prepared by the System Integrator, and per special instruction from equipment or instrumentation Manufacturers.

The Integrator shall provide detailed installation drawings and wiring diagrams for this purpose.

Installation shall include all elements and components of the I&C system and all conduit and interconnecting wiring between all elements, components, and sensors.

WIRE AND CABLE TERMINATION:

Stranded control conductors may be directly terminated using compression type terminals at control panels. Special instrumentation cables shall be terminated in accordance with the recommendations of the Manufacturer of the equipment and subject to review by the Engineer.

No splices shall be used in power, control and/or signal wiring. The wiring shall be continuous from point-to-point.

Terminals and connectors shall be installed with the compression tool recommended by the terminal Manufacturer.

Any control or signal wire landing on a screw terminal shall be terminated with a spade or loop connector.

All wire and cable shall be provided with a wire tag at each termination in accordance with the wire tagging requirements in the specification.

Terminals shall be installed such that there is a minimum of 2" clear space between the terminal strip and the wireway on both sides of the terminal; for ease of wiring.

CONTROL PANEL DESIGN & FABRICATION

GENERAL

Panels shall not be fabricated until Engineer has reviewed and approved the submittals or the integrator has written authorization from the Engineer to construct the panels. It shall be the integrator's responsibility to inform the Engineer in writing if there are limited time constraints that need to be met to start the panel fabrication to meet contract deadlines.

GENERAL LAYOUT

Provide separate wire ways for field wiring and for internal wiring. Provide separate wireways for 120V and DC circuits. Mount PLC at top of control section, Mount digital input and output wireways and terminals on the left hand side and analog I/O terminals and wireways on the right side with power distribution down the middle of the control area. See drawings.

For control panels that contain motor control power equipment: In general the power distribution shall be located toward the left side of the cabinet and the PLC and other control components shall be separate and located in the right side of the cabinet. If power and controls are in the same cabinet, then provide at least 4" of separation between any 480V power wiring or components and the signal wireway, or provide a steel barrier between the power and controls sections.

If panel has intrinsic safe component area – provide space below the UPS in the center of the cabinet at the bottom.

OPERATING DEVICE LOCATION

Operating devices shall be mounted no higher than 6' - 4" and no lower than 4' - 0" above finished floor when panel is installed unless otherwise approved by the Engineer. Operating devices with displays (such as PLC interface, VFD interface, and power monitoring devices) shall be mounted so that the center of the display is between 4'-6" and 5'-0" above finished floor unless otherwise approved by the Engineer.

POWER COMPONENTS

Provide lockable breakers for all motor load circuits to meet NEC lockout tagout requirements.

Provide cabinet power disconnect / door interlocking mechanism as required by UL, NEC, and any other authority.

Provide service entrance rated breaker if required for the application.

Provide each of the motor starters and VFD cabinets with their own electrically isolated 120V control power transformer (CPT) or 120V control power circuit. Control power circuit for hand control shall be from the CPT so that motor loads can be run manually when auto control power circuits have failed.

CONTROL CABINETS

Install PLC I/O card to terminal interface wiring with pre-manufactured, multi-conductor or bundled wire.

Install all terminals on 1" standoffs.

Terminals shall be installed to allow a minimum of 2" of clear space between the terminal and the wireway or any other components.

Coordinate terminals and wireway locations to account for the location of the conduit entrances into the cabinet.

Wire ways shall be 3" deep, width shall be chosen for the application.

Provide separate wire ways for internal and field wiring.

The UPS shall be din rail or shelf mounted – maintain at least 2" space between the bottom of the UPS and the bottom of the cabinet for field wiring.

Provide right angle connectors on cables if the cable connection prevents closing of access doors on equipment within the cabinet or on the control cabinet itself.

FACTORY TESTING & INSPECTION

Prior to delivery to the site, the power and control equipment: (control panels, MCCs, motor starters, VFDs etc.) shall be tested by the System Integrator, all control devices shall be operated and the cabinet shall be powered with rated incoming voltage for at least 2 days. Simulating equipment shall be provided and wired into the control cabinet system for this testing. The entire control system shall be interconnected as it will be installed in the field if the actual equipment is not available, then simulation equipment shall be provided to fully demonstrate the functionality of the system. The System Integrator shall test all functionality of the system and verify proper operation of the hardware and software

Following the System Integrators testing, the power & control equipment shall be tested and inspected by the Design Engineer prior to shipment to the project site. The testing shall include, but not be limited to, operation of all input and output (I/O) points, control devices and motor controllers and demonstration of all control functions with the actual equipment or via a simulation. The System Integrator shall revise, modify,

adjust the system as required by the Engineer during the testing period. . The System Integrator shall inform and coordinate the time of the testing with the Engineer at least 4 weeks prior to the testing date.

The System Integrator shall provide working space, a 6 foot table and 2 office/desk chairs for the test Engineers.

STARTUP AND TESTING

All components of the control system shall be calibrated by the Manufacturer's rep and the Integrator after completion of installation. Each component shall be adjusted to be within the Manufacturer's required range and for the specific application.

Components that cannot be properly calibrated or that are found to exceed the Manufacturer's specified range or accuracy shall be removed and replaced at no additional cost to the Owner.

The control system shall be placed into operation by the Contractor and System Integrator.

All components shall be tested and recorded on check-off forms and shall be witnessed by the Engineer.

FIELD TESTING OF THE CONTROL SYSTEM

GENERAL

When the installation is substantially complete, the Contractor shall commence field testing of the control system. This shall determine that all system components connect up correctly to each other so that the system works as designed.

Field testing of the control system shall take place in 4 phases.

Continuity Testing,

I/O Testing,

Program Testing

System Validation Testing.

CONTINUITY TESTING

As equipment wiring is completed, the Contractor and Hardware Integrator shall perform a continuity test for every control to determine terminal to terminal continuity and verify all control and signal wiring is installed in accordance to the Hardware Integrators wiring diagrams.

I/O TESTING

The entire I&C system shall be I/O tested.

Prior to calling for I/O testing the Contractor shall:

Complete the continuity testing.

Label all wire at both ends.

Submit all associated test and calibration forms (Instrument, motor, wire, etc.)

Run all motors (in HAND) to verify correct operation and rotation

Provide all equipment and instrument labels per spec.

Test operation of “packaged sub systems”

Prior to any equipment to be put into automatic operation, every digital and analog input and output shall be tested for correct operation and witnessed by the Electrical Engineer. The contractor shall provide a set of the PLC Card drawings and instrument and control wiring diagrams on 81/2x11” sheets for a check-off list of all inputs and outputs. If a point cannot be verified within 5 minutes of starting the check that point shall be noted as a punch list item to be corrected and re-tested at a later time.

Definition: Successfully I/O Tested. A piece of equipment of system shall be considered “successfully I/O tested” when all of the I/O for that equipment has been tested and verified by both the programmer and the Electrical Engineer and checked off of the wiring diagrams or PLC I/O card drawings. Note: The Electrical Engineer must witness and verify all I/O testing.

Once all I/O associated with a piece of equipment of system has been **successfully tested**, then the equipment or system will be deemed ready for program testing.

INPUTS:

The Contractor shall simulate an actual field condition whenever possible to provide both the digital and analog signal inputs into the PLC and these will be verified by the programmers. Where an actual field simulation is not practical, then the Contractor shall jumper the digital inputs at a point closest to the field device as possible and shall use an analog loop simulator for analog inputs.

Analog inputs shall be tested at 0,25%, 50%, and 100% of full range.

OUTPUTS:

The programmer will simulate outputs from the PLC and the Contractor shall verify the field operation of the output. The field operation verification shall be by actual operation of equipment when possible. When actual field operation of equipment is not practical for verification, then the Contractor shall use volt and amp metering to verify digital and signal outputs.

Analog outputs shall be tested at 0,25%, 50%, and 100% of full range.

PROGRAM TESTING

The Contractor and Integrator shall provide field support to the programmer for testing of the program. The Contractor shall provide field simulation of equipment as needed by

the programmer to test all monitoring and alarm functions of the programming. The Contractor and Integrator shall anticipate that the program testing will require up to a total of 4 hours of field support time for this project. The cost for this time shall be included in the bid.

SYSTEM VALIDATION TESTING

After the program testing is complete, validation testing shall be by the Hardware and Software Engineer and Contractor, with the Owner and Engineer present. Validation testing shall include operation and verification of all control components and features of the entire control system.

The Contractor shall simulate various field conditions to test all control operations, monitoring and alarms for all systems and equipment.

The Contractor shall inform the Engineer of the testing schedule at least one week prior to the commencement of testing. Validation testing shall be considered complete when the Owner and Engineer have determined that all of the original system requirements have been met.

The System Integrator shall revise, modify, adjust the system as required during and following start-up to provide the operation required by the contract documents.

Note: the Engineer shall not be called out by the Contractor for validation testing on equipment until all components are installed, all wiring points have been checked, and operation **has been** tested **and verified** by the Contractor.

COMMISSIONING

Once all systems have passed validation testing, then the facility will be operated for 2 weeks or time period as determined in the documents to verify all component and system operations prior to final acceptance.

SYSTEM MAINTENANCE

The System Integrator shall be responsible for maintenance of the system from time of start-up to the date of acceptance, by formal action of the Owner, of all work under the contract. The System Integrator shall correct deficiencies and defects and make any and all repairs, replacements, modifications, and adjustments as malfunctions or failures occur. The System Integrator shall perform all such work required or considered to be required by the Owner to cause and maintain proper operation of the system and to properly maintain the system.

SERVICES OF SYSTEM INTEGRATOR

General: An authorized service representative of the control panel System Integrator shall be present at the Site for two ½ days to furnish the services listed below. For the

purpose of this paragraph, a 1/2 Day is defined as a 4 hour period excluding travel time.

Inspection, Startup, Field Adjustment: The authorized service representative shall supervise the following and certify the equipment and controls have been properly installed, aligned, and readied for operation.

Installation of the equipment

Inspection, checking, and adjusting the equipment

Startup and field testing for proper operation

Performing field adjustments such that the equipment installation and operation comply with requirements.

Instruction of Owner's Personnel: The authorized representative shall instruct the Owner's personnel in the operation and maintenance of the equipment, including step by step troubleshooting with test equipment. Instruction shall be specific to the equipment models provided. Training shall be scheduled a minimum of 2 weeks in advance of the session. Training shall a minimum of 1 hour.

Proposed training materials shall be submitted for review, and comments shall be incorporated. Training materials shall remain with the trainees. The Owner may videotape the training for later use with the Owner's personnel. The Hardware Integrator shall conduct specifically organized training sessions in operation and maintenance of the control system 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 control system. Training shall include, but not be limited to, the following:

Preventative maintenance procedures

Trouble-shooting

Calibration

Testing

Replacement of components

Automatic mode operation

Manual mode operation

OPERATION AND MAINTENANCE DATA

The System Integrator shall prepare and assemble detailed operation and maintenance manuals in accordance with the project general requirements . The manuals shall include, but not be limited to, the following:

Preventative maintenance procedures

Trouble-shooting

Calibration

Testing

Replacement of components

Automatic mode operation

Manual mode operation

System schematics / shop drawings

Electronic copy on CD ROM of all shop drawings in AutoCAD version 2000 or newer

As-built wiring diagrams of cabinet and enclosure contained assemblies

Catalog data and complete parts list for all equipment and control devices

Listing of recommended spare parts

Listing of recommended maintenance tools and equipment.

1 copy of the entire O&M manual shall be provided in electronic PDF format on CD ROMs.

RECORD DRAWINGS

The System Integrator shall be responsible to provide a clean and neatly marked up set of record drawings showing any changes from the submittal and contract drawings. These drawings shall be provided prior to final approval of the project and release of the retainage.

WIRING DIAGRAM EXAMPLES

GENERAL

The wiring diagrams shall be drawn and submitted in accordance with the following example drawings. These drawings are for drawing formatting reference only and do not necessarily have any actual application to the facility control system.

EQUIPMENT WIRING DIAGRAMS (LOOP DWGS)

Provide one page wiring diagram for each motor / equipment load showing all of the control wiring associated with that load. Drawing shall show the motor control center wiring , field wiring, PLC I/O, and control panel wiring all on one sheet; complete with terminal numbers and wire numbers. Include PLC Card information rack and slot and I/O designation for each point.

INSTRUMENT WIRING DIAGRAMS (LOOP DWGS)

Show all wiring associated with each instrument on one page – including power supply location and signal wiring. Show all terminals numbers and wire numbers. Designate boundaries between field and control panels and etc.

NETWORK DIAGRAM

Provide detailed drawings showing all of the components of the communications network – include all terminals and wire numbering. Designate equipment locations.

PLC I/O CARD DRAWINGS

Provide I/O card drawings for all PLC I/O cards per the example drawing. Drawings shall show details specific to each I/O card, name of each input or output, reference drawing number for associated EQUIPMENT AND INSTRUMENT WIRING DIAGRAM, card number, slot number, control panel terminal and wire numbers, etc.

END OF SECTION