

SECTION 15270

FLOW METERS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work includes the supply, installation and start-up of flow meters and related appurtenances at the following locations:

- 1. RAS Flow Meter
- 2. WAS Flow Meter

1.02 RELATED EQUIPMENT SPECIFIED ELSEWHERE

- A. Section 11360 – Sludge Flow Meter
- B. Section 11360 – Polymer Flow Meter
- C. Section 16901 – Effluent Flow Meter

1.03 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.
- B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- C. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

1.04 RELATED SECTIONS

- A. Section 13110 – RAS Pump Station
- B. Section 15201 – Process Piping

PART 2 PRODUCTS

2.01 ELECTROMAGNETIC FLOW METER / SIGNAL CONVERTER

- A. Where designated, flow meters shall be electromagnetic flow meters,

mounted directly in line with the flow being measured. Meters shall not require the insertion of any hardware within the flow stream.

- B. Meter accuracy shall be $\pm 0.25\%$ of rate for flows in the range of 1 to 33 fps and 0.5% of rate for flows in the range of 0.1 to 1 fps.
- C. Meters shall be lined with PTFE to inhibit corrosion. All lining materials shall be compatible with wastewater and shall be NSF approved.
- D. Meters shall be supplied with flanged ends unless otherwise noted. Flanges shall be rated for 150 psi or 300 psi service as designated.
- E. Meters shall be rated NEMA 6P and suitable for installation in areas which may become flooded. Meter shall incorporate a junction box for interface of the remote signal converter cable.
- F. Meters shall be supplied with stainless steel grounding rings. Grounding rings shall be installed in accordance with the manufacturer's recommendations.
- G. Meters shall be M-Series Model M-2000 as manufactured by Badger Meter, Inc., Milwaukee, WI, a similar meter manufactured by Sparling Instruments, El Monte, CA, or approved equal.
- H. Each electromagnetic flow meter shall be supplied with a signal converter designed for remote mount from the meter. The signal converter shall be microprocessor based and shall be specifically designed for use with electromagnetic based flow meters. The converter shall process the signals received from the flow meter and shall convert it to a 4-20 mA and scaled output signal for use by other control equipment.
- I. The signal converter shall be housed in a NEMA 4X enclosure. Enclosure shall be wall mountable and shall be supplied with any required brackets and hardware.
- J. Signal converter shall be designed for a 115V, 60 Hz power supply.
- K. Where proposed for exterior installation the signal converters shall be equipped with a sun shade to improve readability of the display and to deflect direct sunlight from the display.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide meters in accordance with the Equipment Schedule.

- B. Install meters in accordance with manufacturer's recommendations.
- C. Coordinate installation with Division 16 for power supply to the meter(s) and for interface of the meter output with related equipment.
- D. If requested by Owner, provide start-up assistance and training for Owner personnel following installation of meters and signal converters.

3.02 EQUIPMENT SCHEDULE

- A. Provide meters and related accessories in accordance with the following schedule. Refer to the Drawings for reference on location of the meters.

<u>Location</u>	<u>Size</u>	<u>Type</u>	<u>Pressure Rating</u>
RAS Meter	4"	Electromagnetic	150 psi
WAS Meter	4"	Electromagnetic	150 psi

END OF SECTION

SECTION 15410

PLUMBING FIXTURES AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

- A. Provide plumbing fixtures, fittings and equipment.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.
- B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- C. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

PART 2 PRODUCTS

2.01 ACCEPTABLE PRODUCTS

- A. Refer to schedule on Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.02 PREPARATION

- A. Rough-in-fixture piping connections in accordance with a minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.

- B. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with manufacturer's recommended sealant, color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.04 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.05 CLEANING

- A. Clean plumbing fixtures and equipment.

3.06 PROTECTION OF FINISHED WORK

- A. Do not permit use of fixtures during construction.

END OF SECTION

SECTION 15775

ELECTRIC UNIT HEATERS

PART 1 GENERAL

1.01 SCOPE:

- A. This section specifies the requirements for electric unit heating equipment.

1.02 SUBMITTALS:

- A. Refer to Section 01300 for submittal procedure.
- B. Provide data on heater performance including, but not limited to, entering and leaving air temperatures, capacity, and airflow.
- C. Provide shop drawing showing heater dimensions, weight, service access requirements and electrical requirements.
- D. Provide manufacturer's instructions, indicate installation and support requirements.
- E. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list. Contact names and information for parts and assistance shall also be provided.

1.03 QUALITY ASSURANCE:

- A. All electric heating equipment shall be U.L. listed and so labeled.

PART 2 PRODUCTS

2.01 ELECTRIC WALL HEATERS:

- A. Heaters shall be complete with fully enclosed permanently lubricated motor with fan, heating elements, inlet and outlet grilles, integral built-in tamper-proof thermostat, automatic reset overheat protection, disconnect switch, wall box and cover.
- B. Cabinet design shall be of the surface mount type. Inlet and outlet grilles shall be of 16 gauge steel, bar grille type to prevent insertion of objects into the fan or heating element.
- C. Heating elements shall consist of steel sheathed enclosed, finned tubular heaters. An integral two-pole terminal block shall be provided for wiring connections for each heater.

- D. The built-in thermostat shall be of the sensitive bulb and capillary type, fully enclosed, snap action to prevent radio and television interference.
- E. See Drawings for scheduled capacities.
- F. Electric wall heaters shall be QMark Type CWH3000 or equal.

2.02 ELECTRIC UNIT HEATERS / NON-HAZARDOUS AREAS:

- A. Heater shall be complete with heating elements, fan motor, propeller type fans, thermal overload switch, inlet and outlet grilles, heavy duty housing, mounting bracket for horizontal air discharge, and with suitable enclosure for wiring connections, all of which components shall be factory assembled as a complete unit. Provide for each heater a suitable disconnect switch, pilot duty thermostat, magnetic contactor and any items as scheduled or shown on the Drawings.
- B. Heating elements shall be enclosed metal sheathed finned tubular type with corrosion resistant finish. Automatic reset thermal overload switches shall be factory installed as a component part of each heater. Units shall incorporate a heating contactor.
- C. Motor shall be totally enclosed continuous fan-duty sleeve bearing type and shall be provided with thermal overload protection.
- D. Fans shall be aluminum, directly connected to the fan motor, dynamically balanced and designed specifically for unit heater application.
- E. The complete heater assembly shall be enclosed in a 20 gauge steel casing which shall have baked-on enamel finish. A removable panel shall provide access to internal electrical wiring. Units shall be equipped with integral louvers to provide control of discharged air.
- F. Where indicated on the Drawings, controls shall include fan delay, 24V/120V control transformer, and unit mounted thermostat. Provide power disconnect switch.
- G. Heaters shall be of capacity shown on the Drawings.
- H. Electric unit heaters shall be Chromolox HVH or equal.

2.03 ELECTRIC UNIT HEATERS / HAZARDOUS AREAS:

A. General:

1. The explosion-proof unit heater(s) shall be supplied and installed in

accordance with the plans and specifications, with ratings as listed on the Drawings.

2. The unit heater(s) shall be Underwriters Laboratories Inc. Listed for continuous use in Class I, Division 1, Group D Hazardous Locations and shall be rated for National Electric Code Temperature Code T3B, 165°F [329°C].

B. Heat Exchanger:

1. The heat exchanger shall be a liquid to air type consisting of steel tubes with integral aluminum fins.
 - a. The heat exchanger shall operate at a normal pressure between 20 and 25 psig, protected by a pressure relief device and factory helium leak tested to assure leak-proof design.
2. The heat exchanger shall be filled and sealed to design level with a custom blended, propylene-glycol and water solution including inhibitors to provide superior corrosion protection.
3. The heat exchanger shall include a heavy duty flanged immersion heater consisting of seamless copper heating elements brazed into a heavy steel flange. The elements shall consist of high quality resistance wire imbedded in a magnesium oxide refractory which has been compacted for excellent dielectric strength and optimum thermal conductivity. The heater is to be protected by a high temperature limit cutout. The limit will be a manual reset type to shut off the heater if the fluid temperature rises due to a lack of heat dissipation.

C. Fan and Motor Assembly:

1. The Fan Assembly shall include a ball bearing, permanently lubricated, thermally protected explosion-proof motor rated for continuous duty at 104°F. (40°C).
2. The Fan shall be aluminum to prevent sparking and be epoxy coated to prevent corrosion. The fan shall be directly connected to the motor, dynamically balanced, and designated specifically for the heater application.
3. The Fan and Motor Assembly shall be equipped with a combination heavy-duty polyester powder-coated guard, shock mounted at four points to absorb any motor vibration.

D. Control Center:

1. The heater control center shall include the following items completely factory prewired and tested, and enclosed in a NEMA 7/9 explosion-proof control enclosure mounted on the side of the heater cabinet.
2. The control center shall include a magnetic contactor sized to handle heater and motor, and shall be rated for 500,000 cycles of operation.

The encapsulated severe duty coil shall be rated 120V.

3. The control center shall include a control voltage transformer, the primary voltage being the same as the heater voltage and the secondary to be 120V.
4. The control center shall include a terminal block for remote thermostat connection.

E. Cabinet Assembly:

1. The cabinet assembly to be fabricated from 14 gauge steel with polyester powder coating for protection from corrosive atmospheres.
2. The cabinet shall include two (2) 5/8 inch NC threaded mounting holes located on the top.
3. The cabinet front shall be easily removable for inspection and cleaning of the heat exchange assembly by removal of metal fasteners. The front shall include adjustable louvers to direct the air flow.

F. Mounting:

1. Heaters shall be provided with a mounting kit specifically designed to bear the weight of the heater assembly.
2. Mounting kit type (wall, hanging, pole-mounted) shall be as outlined on the Drawings.

G. Manufacturer / Model:

1. The unit heaters for hazardous locations shall be Chromalox Series CXH-EP Unit Heaters or equal and shall be suitable for appropriate hazardous area installations.

2.04 BULLDOG STYLE FAN FORCED UNIT HEATER

- A. Heaters shall be complete with fully enclosed permanently lubricated motor with fan, heating elements, inlet and outlet grilles, integral built-in tamper-proof thermostat, and automatic reset overheat protection.
- B. Cabinet design shall be of the portable type with swivel base that supports wall, ceiling or floor installation. Inlet and outlet grilles shall be bar grille type to prevent insertion of objects into the fan or heating element.
- C. Heating elements shall consist of steel sheathed enclosed, finned tubular heaters.
- D. Unit shall be rated for a 10' air throw at 262 CFM minimum.
- E. Unit shall operate on 240V or 208V, single phase electric service. The

heater shall be UL listed.

F. See Drawings for scheduled capacities.

G. Electric bulldog style heaters shall be TPI Corporation 680 Series or equal.

PART 3 EXECUTION

3.01 INSTALLATION:

A. Install heaters in accordance with manufacturer's U.L. listing for minimum clearance.

B. Mount electric unit heaters at locations and heights as outlined on the Drawings.

END OF SECTION

SECTION 15820

DEHUMIDIFICATION EQUIPMENT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Work includes the supply, installation and start-up of high efficiency dehumidification equipment.

1.02 SUBMITTALS

- A. Product Data: Submit manufacturer's product data and installation instructions for units.
- B. Shop Drawings: Submit shop drawings indicating material characteristics, details of construction, connections, and relationship with adjacent construction.
- C. Operation and Maintenance Data: Submit manufacturer's operation and maintenance data, including operating instructions, list of spare parts and maintenance schedule.

PART 2 PRODUCTS

2.01 HIGH EFFICIENCY DEHUMIDIFICATION EQUIPMENT

- A. Provide dehumidification equipment which meets the requirements listed below.
- B. Acceptable Manufacturers/Model: Quest/Hi-E Dry Model 120, a comparable model manufactured by Dry-Air, or equal.
- C. Provide a high-efficiency dehumidifier that utilizes refrigeration to cool the incoming air stream below its dew point as it passes through the dehumidification (evaporator) coil. The cooled and dried air shall be used to pre-cool the incoming air stream to result in a 200 to 300 percent increase in overall efficiency.
- D. The unit shall be controlled by an integral humidistat with settings from 20 to 80 percent relative humidity and a positive "on" and "off" setting.
- E. The unit shall contain a blower switch that shall permit continuous blower operation independent of dehumidification.

- F. The unit shall be portable and be provided with four casters.
- G. The unit shall contain an internal condensate pump capable of lifting condensate 12 feet. Twenty (20) feet of condensate hose shall be provided.
- H. The wiring of the unit shall be through a factory installed 6-foot power cord; 115 volt with ground.

PART 3 EXECUTION

3.01 INSTALLATION

- A. All dehumidification units shall be factory assembled and tested.
- B. Install unit with vibration isolators as recommended or supplied by the manufacturer.
- C. Coordinate installation with Division 16 for power supply to the unit.
- D. If requested by Owner, provide start-up assistance and training for Owner personnel following installation of unit.

END OF SECTION

SECTION 15833

CAST ALUMINUM PRESSURE BLOWERS

PART 1 GENERAL

1.01 SCOPE:

- A. Section includes radial blade Industrial blowers, direct driven.

1.02 REFERENCE STANDARDS

- A. Air Movement and Control Association International, Inc. (AMCA): www.amca.org:

- 1. AMCA Standard 204 - Balance Quality and Vibration Levels for Fans
- 2. AMCA Standard 210 - ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
- 3. AMCA Standard 300 - Reverberant Room Method for Sound Testing of Fans

- B. National Electrical Manufacturers Association (NEMA): www.nema.org:

- 1. NEMA MG 1 – Motors and Generators

- C. National Fire Protection Association (NFPA): www.nfpa.org:

- 1. NFPA 70 - National Electrical Code

1.03 SUBMITTALS:

- A. Refer to Section 01300 for submittal procedure.

- B. Product Data: Include the following:

- 1. Rated capacities and operating characteristics.
- 2. Blower Performance Data: Blower performance curves with flow, static pressure and horsepower.
- 3. Sound Performance Data: Fan sound power levels in eight octave bands and, A-weighted overall sound power level or some values.
- 4. Motor ratings and electrical characteristics.
- 5. Furnished specialty components.
- 6. Specified accessories.
- 7. Dimensioned standard drawings indicating dimensions, weights, and attachments to other work.

- C. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Approved ISO 9001-compliant manufacturer listed in this Section with minimum 10 years' experience in manufacture of similar products in successful use in similar applications, and with an ASME NQA-1 compliant Program.
- B. AMCA Compliance: Provide fan units tested in accordance with AMCA Standard 210 (air performance) and AMCA Standard 300 (sound performance) in an AMCA-accredited laboratory.

1.05 COORDINATION

- A. Coordinate sizes and locations of supports required for blower units.
- B. Coordinate sizes and locations of equipment supports.

1.06 FIELD CONDITIONS

- A. Handling and Storage: Handle and store blower units in accordance with manufacturer's published instructions. Examine units upon delivery for damage. Store units protected from weather.

1.07 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to furnish replacement components for blower units that demonstrate defects in workmanship or materials under normal use within warranty period specified.

- 1. Warranty Period: 12 months from startup or 18 months from shipment by manufacturer, whichever first occurs.

PART 2 PRODUCTS

2.01 MANUFACTURER / MODEL

- A. Provide cast aluminum pressure blower Cincinnati Fan Model PB-10A, a similar model manufactured by Twin City Fan, or equal.

2.02 PERFORMANCE REQUIREMENTS

- A. Blower Performance Ratings: Sea level - based.

2.03 DIRECT - DRIVEN CAST ALUMINUM PRESSURE BLOWERS

- A. General: Permanently attach nameplate displaying serial number and unit information.
- B. Configuration: Provide unit with blower inlet and discharge directions as indicated on Drawings.
- C. Blower Wheels: Provide cast aluminum wheel with radial bladed backplate or backward curved design. Provide wheels suitable for exhaust purposes where low volume and high pressure applications exist.
- D. Housing:
 - 1. Heavy duty cast aluminum.
 - 2. Provide eight standard mounting positions to direct discharge direction.
 - 3. Provide flanged connections without pre-punched bolt holes at fan inlet.
- E. Supports: Steel angle, intermittently welded with calk at joints between welds.
- F. Motors: Comply with NEMA MG-1 for designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - a. Voltage: 230V; 1 phase; 60 Hz.
 - b. Enclosure Type: Totally Enclosed Fan Cooled (TEFC).
 - 2. Disconnect Switch: Unfused, NEMA 4X.
 - a. Ship disconnect switch loose for field mounting and wiring.
- G. Vibration Isolation:
 - 1. Provide isolation of blower from connected piping, duct work and foundation in accordance with fan manufacturer's requirements.
- H. Finishes:
 - 1. Do not apply coatings to aluminum components.
 - 2. After fabrication, clean and chemically pretreat ferrous metal parts by phosphatization.
 - 3. Apply two coats of air dried enamel finish to carbon steel components.

I. Accessories:

1. Inlet and Outlet Guards: Removable, galvanized steel wire with radial supports.
 - a. Provide screens at fan outlet.

J. Blower Capacities and Characteristics: Refer to Drawing schedule.

2.04 SOURCE QUALITY CONTROL

- A. Factory Run Test: Test run assembled blower units prior to shipment at specified operating speed or maximum RPM allowed. Statically and dynamically balance each wheel in accordance with AMCA Standard 204 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Obtain balance readings by electronic equipment in the axial, vertical, and horizontal directions on each set of bearings.

1. Submit report of factory run test.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive blowers. Notify Engineer regarding conditions that may adversely affect installation, operation, or maintenance of blowers. Proceed with installation once conditions are in accordance with manufacturer's published instructions.

3.02 PROTECTION

- A. Protect adjacent construction and finished surfaces during installation and testing.
- B. Except for operational testing, do not operate blower during construction.

3.03 INSTALLATION

- A. Install blowers in accordance with Contract documents and manufacturer's published instructions.
- B. Install blower units with adequate clearances for service and maintenance.
- C. Duct Connections: Drawings indicate general arrangement of ducts and duct accessories. Where indicated on Drawings, make final duct connections with flexible connectors.

D. Install connecting ducts with adequate clearances for service and maintenance.

E. Electrical Connections: Connect wiring in accordance with NFPA 70.

3.04 ADJUSTING AND CLEANING

A. Adjust, clean, and maintain installed blower units in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 15834

PROPELLER FANS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes propeller wall fans, direct-driven.

1.02 REFERENCE STANDARDS

- A. Air Movement and Control Association International, Inc. (ACMA): www.acma.org:

- 1. AMCA Standard 204 - Balance Quality and Vibration Levels for Fans
- 2. AMCA Standard 205 - Energy Efficiency Classification for Fans
- 3. AMCA Standard 210 - ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
- 4. AMCA Publication 211 - Certified Ratings Program - Product Rating Manual for Fan Air Performance
- 5. AMCA Standard 300 - Reverberant Room Method for Sound Testing of Fans
- 6. AMCA Publication 311 - Certified Ratings Program - Product Rating Manual For Fan Sound Performance

- B. National Electrical Manufacturers Association (NEMA): www.nema.org:

- 1. MG 1 – Motors and Generators

- C. National Fire Protection Association (NFPA): www.nfpa.org:

- 1. NFPA 70 - National Electrical Code

- D. Underwriters Laboratories, Inc. (UL): www.ul.com:

- 1. UL 705 - Standard for Power Ventilators

1.03 SUBMITTALS

- A. Product Data: Include the following:

- 1. Rated capacities and operating characteristics.
- 2. Fan Performance Data: Fan performance curves with flow, static pressure and horsepower.
- 3. Sound Performance Data: Fan sound power levels in eight octave bands

and, A-weighted overall sound power level or sone values.

4. Motor ratings and electrical characteristics.
5. Furnished specialty components.
6. Specified accessories.
7. Dimensioned standard drawings indicating dimensions, weights, and attachments to other work.

1.04 OPERATION AND MAINTENANCE DATA

- A. Include routine maintenance, adjustment requirements, safety information, and troubleshooting guide. Contact names and information for parts and assistance shall also be provided.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Approved ISO 9001-compliant manufacturer listed in this Section with minimum 10 years' experience in manufacture of similar products in successful use in similar applications, and with an ASME NQA-1 compliant Program.

- B. AMCA Compliance:

1. Provide fan types tested in accordance with AMCA Standard 210 (air performance) and AMCA Standard 300 (sound performance) in an AMCA-accredited laboratory.
2. Provide fan units rated according to AMCA Standard 211 (air performance) and AMCA Standard 311 (sound performance).
3. Provide fan units rated according to AMCA Standard 205 (fan efficiency grade).

1.06 COORDINATION

- A. Coordinate sizes and locations of supports required for fan units.
- B. Coordinate sizes and locations of equipment supports, roof curbs, and roof penetrations.

1.07 FIELD CONDITIONS

- A. Handling and Storage: Handle and store fan units in accordance with manufacturer's published instructions. Examine units upon delivery for damage. Store units protected from weather.

1.08 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which

manufacturer agrees to furnish replacement components for fan units that demonstrate defects in workmanship or materials under normal use within warranty period specified.

1. Warranty Period: 12 months from date of substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Basis-of-Design Manufacturer: Provide fan units manufactured by Twin City Fan & Blower, Minneapolis MN; (763) 551-7600; email: tcf_sales@tcf.com; website: www.tcf.com or Engineer approved equal.
- B. Source Limitations: Obtain mixed flow fans from a single manufacturer.

2.02 PERFORMANCE REQUIREMENTS

- A. Fan Performance Ratings: Project site elevation-based.
- B. AMCA Seal: Provide units that bear the AMCA-Certified Ratings Seal.
- C. Compliance:
 1. Classified under AMCA Standard 205.
 2. Provide units listed in accordance with UL 705.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.

2.03 PROPELLER WALL FANS

- A. Propeller Wall Fans: Medium duty direct-driven propeller wall fans for general-purpose ventilation.
 1. Basis of Design Product: Twin City Fan & Blower, Model WPD.
 2. Permanently attach nameplate displaying serial number and unit information.
- B. Fan Capacities and Characteristics: Refer to Drawing schedule.
- C. Propeller: Cast aluminum blades in cast aluminum hub. Hub secured to motor shaft with tapered bushing.
 1. Statically and dynamically balance propeller.
- D. Motors: Comply with NEMA MG-1 for designation, temperature rating,

service factor, enclosure type, and efficiency requirements.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 2. Motor Speed: Nominal 1,800 rpm.
 3. Motor Frame: Motor frame size shall be compatible with fan.
 4. Motor - Single Phase: Induction type, with split phase construction and capacitor start. Provide permanently lubricated heavy duty ball bearings.
 - a. Totally Enclosed Fan Cooled (TEFC) enclosure in locations not designated as Class 1, Division 1, Group D.
 - b. Explosion Proof (EXP) enclosure in locations designated as Class 1, Division 1, Group D.
 5. Efficiency Rating: Provide high efficiency motors designed for continuous operation.
 6. Provide unfused disconnect switch as outlined on Drawings.
 - a. Ship disconnect switch loose for field mounting and wiring.
- E. Frame: Formed square tube steel supports bolted to steel panel with formed inlet venturi and pre-punched holes for mounting anchors. Motor mounting plate bolted to frame tubes.
- F. Finish: Galvanized mill finish internal parts, and uncoated external aluminum parts exposed to weather.
- G. Accessories
1. Wall Box: 16 Ga galvanized steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of inlet screen, backdraft damper, weather hood, outlet screen, damper guard, and disconnect switch.
 2. OSHA Motor Side Guard: Complies with OSHA standards by completely enclosing motor and drive components. Constructed of galvanized steel sides and galvanized wire screen.
 3. Weather Hood: Galvanized steel hood to shield fan opening from snow and rain. Include bird screen of galvanized wire.
 4. Damper Guard: Provide to protect backdraft damper from birds and debris. Include OSHA-compliant screen. Pre-punch mounting holes.
 5. Backdraft Damper, Automatic, parallel-blade type. Adjust backdraft damper to close when fan is not running.
 - a. Fabricate frame from galvanized steel.
 - b. Fabricate blades from aluminum, mill finish, with vinyl edge seals.
- H. Fan Capacities and Characteristics: Refer to Drawing schedule.

2.04 SOURCE QUALITY CONTROL

- A. Certify sound-power level ratings according to AMCA Publication 311. Label fans with the AMCA-Certified Ratings Seal.
- B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 211. Label fans with the AMCA-Certified Ratings Seal.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive fans. Notify Engineer regarding conditions that may adversely affect installation, operation, or maintenance of fans. Proceed with installation once conditions are in accordance with manufacturer's published instructions.

3.02 PROTECTION

- A. Protect adjacent construction and finished surfaces during installation and testing.
- B. Except for operational testing, do not operate fan during construction.

3.03 INSTALLATION

- A. Install fans in accordance with Contract documents and manufacturer's published instructions.
- B. Electrical Connections: Connect wiring in accordance with NFPA 70.
 - 1. Ground and bond equipment according to Division 16.

3.04 FIELD QUALITY CONTROL

- A. Contractor shall perform requisite field tests and inspections. Verify that unit is secured to supports, and that duct and electrical connections are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Submit test and inspection reports.

3.05 ADJUSTING AND CLEANING

- A. Adjust, clean, and maintain installed fan units in accordance with

manufacturer's published instructions.

END OF SECTION

SECTION 15835

SIDEWALL MOUNTED TRANSFER FANS

PART 1 GENERAL

1.01 SCOPE

- A. HVAC Power Ventilators

1.02 REFERENCES

- A. Air Movement and Control Association Inc. (AMCA):

1. 99 - Standards Handbook
2. 200 - Publication, Air Systems
3. 201-90 - Publication, Fans and Systems
4. 202-88 - Publication, Troubleshooting
5. 203-90 - Publication, Field Performance Measurement of Fan Systems
6. 211-05 - Publication, Certified Ratings Program – Product Rating Manual for Fan Air Performance
7. 300-96 - Standard Reverberant Room Method for Sound Testing of Fans
8. 311-05 - Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
9. 99-0401-86 - Classification for Spark Resistant Construction
10. 99-2408-69 - Operating Limits for Centrifugal Fans

- B. Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):

1. 204-05 - Standard Balance Quality and Vibration Levels for Fans
2. 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

- C. National Fire Protection Association (NFPA):

1. 70 - National Electrical Code
2. 90A-02 - Standard for the Installation of Air-Conditioning and Ventilating Systems

1.03 SUBMITTALS

- A. General: Submit in accordance with Section 01300 Submittal Procedures.
- B. Provide dimensional drawings and product data on each fan.

- C. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- D. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones.
- E. Strictly adhere to QUALITY ASSURANCE requirements as stated in Section 1.04 of this specification.
- F. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance.
- G. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty, electrical wiring diagrams, contact names and information for parts and assistance shall also be provided.

1.04 QUALITY ASSURANCE

- A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air performance seal.
- B. Classification for Spark Resistant Construction, levels A, B and C, conform to AMCA 99.
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).
- D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.

- C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.06 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

1.07 MAINTENANCE

- A. Refer to Manufacturer's Installation, Operation and Maintenance Manual (IOM), to find maintenance procedures.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Greenheck, P.O. Box 410, Schofield, Wisconsin 54476. Phone (715) 359-6171. Fax (715)355-2399. Website: www.greenheck.com.
- B. Or Equal.

2.02 DIRECT DRIVE SIDEWALL MOUNTED PROPELLER TRANSFER FANS

A. General Description:

1. Sidewall mounted applications for economy and reliability in small size, high volume applications.
2. Performance capabilities up to 500 cubic feet per minute (cfm) and static pressure to 0.4 inches of water gauge.
3. Fans are available in sizes that can fit in place of a standard 16 by 8 inch concrete block.
4. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number.

B. Wheel:

1. Propeller shall be composite blade and hubs attached directly to motor shaft.
2. Statically and dynamically balanced in accordance to AMCA Standard 204-05.

C. Motors:

1. Motor enclosures shall be a open dripproof (ODP): opening in the frame body and or end.
2. Motors are permanently lubricated, carefully matched to the fan load.
3. Accessible for maintenance.

D. Housing:

1. Corrosion resistant galvanized steel housing.
2. Mounting flanges.

E. Grille:

1. Constructed of powder coated steel.
2. Tinnerman clips for mounting.

F. Power Supply: Internal plug type power connection to facilitate easy removal of power supply.

G. Disconnect Switches:

1. NEMA 1 rated, factory standard.
2. Positive electrical shut-off.
3. Wired from fan motor to junction box installed within motor compartment.

H. Finish: Baked Enamel.

PART 3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions.

3.02 EXAMINATION

- A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.03 PREPARATION

- A. Ensure wall openings are accurately aligned, correctly located, and in tolerance.

3.04 INSTALLATION

- A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings.
- B. Install fans in accordance with manufacturer's instructions.

3.05 SYSTEM STARTUP

- A. Refer to Installation, Operation, and Maintenance Manual (IOM).

3.06 ADJUSTING

- A. Adjust exhaust fans to function properly.
- B. Lubricate bearings.
- C. Adjust drive for final system balancing.
- D. Check wheel overlap.

3.07 CLEANING

- A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

3.08 PROTECTION

- A. Protect installed product and finished surfaces from damage during construction.
- B. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 15836

ROOF DOWNBLAST CENTRIFUGAL EXHAUST FAN

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: HVAC Power Ventilators

1.02 REFERENCES

- A. Air Movement and Control Association Inc. (AMCA):

1. 99 - Standards Handbook
2. 200 - Publication, Air Systems
3. 201-90 - Publication, Fans and Systems
4. 202-88 - Publication, Troubleshooting
5. 203-90 - Publication, Field Performance Measurement of Fan Systems
6. 211-05 - Publication, Certified Ratings Program – Product Rating Manual for Fan Air Performance
7. 300-96 - Standard Reverberant Room Method for Sound Testing of Fans
8. 311-05 - Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
9. 99-0401-86 - Classification for Spark Resistant Construction
10. 99-2408-69 - Operating Limits for Centrifugal Fans

- B. Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):

1. 204-05 - Standard Balance Quality and Vibration Levels for Fans
2. 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

- C. National Fire Protection Association (NFPA)

1. 70 - National Electrical Code
2. 90A-02 - Standard for the Installation of Air-Conditioning and Ventilating

1.03 SUBMITTALS

- A. General: Submit in accordance with Section 01300 Submittals.
- B. Provide dimensional drawings and product data on each fan.

- C. Provide fan curves for each fan at the specified operation point, with the flow, static pressure and horsepower clearly plotted.
- D. Provide outlet velocity and fan's inlet sound power readings for the eight octave bands, decibels, and sones.
- E. Strictly adhere to QUALITY ASSURANCE requirements as stated in Section 1.04 of this specification.
- F. Provide manufacturer's certification that exhaust fans are licensed to bear Air Movement and Control Association (AMCA), Certified Rating Seal for sound and air performance.
- G. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pulley adjustment, receiving, handling, storage, safety information and cleaning. A troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.04 QUALITY ASSURANCE

- A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for air and sound performance seal.
- B. Classification for Spark Resistant Construction, levels A, B, and C conform to AMCA 99.
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).
- D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.

- C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.06 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
 - 1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the date of substantial completion. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.
 - 2. Motor Warranty is warranted by the motor manufacturer for a period of one year from the date of substantial completion. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station.

PART 2 PRODUCTS

2.01 MANUFACTURER / MODEL

- A. Roof downblast (direct drive) centrifugal exhaust fans shall be Greenheck Model G, or equal. Fan size and capacity shall be as noted on the Drawings.

2.02 EQUIPMENT

- A. General Description:

- 1. Downblast fan shall be for roof mounted applications.
 - 2. Fan shall be a direct drive configuration.
 - 3. Maximum continuous operating temperature shall be 180° F.
 - 4. Each fan shall bear a permanently affixed manufacturer's engraved metal nameplate containing the model number and individual serial number.

- B. Wheel:

- 1. Constructed of aluminum.
 - 2. Non-overloading, backward inclined centrifugal.

3. Statically and dynamically balanced in accordance to AMCA Standard 204-05.
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motors:

1. AC Induction Motor
 - a. Motor enclosures: Totally enclosed fan cooled, high efficiency.
 - b. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase.
 - c. Mounted on vibration isolators, out of the airstream
 - d. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants.
 - e. Accessible for maintenance.

D. Housing:

1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum.
2. Shroud shall have an integral rolled bead for extra strength.
3. Shroud shall be drawn from a disc and direct air downward.
4. Lower windband shall have a formed edge for added strength.
5. Motor cover shall be drawn from a disc.
6. All housing components shall have final thicknesses equal to or greater than preformed thickness.
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment.
8. Rigid internal support structure.
9. Leak proof.

E. Housing Supports and Drive Frame:

1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.

F. Vibration Isolation:

1. Rubber isolators.
2. Sized to match the weight of each fan.

G. Disconnect Switches:

1. NEMA rated: 12
2. Positive electrical shut-off.

3. Wired from fan motor to junction box installed within motor compartment.

H. Options/Accessories:

1. Birdscreen:
 - a. Material Type: Galvanized
 - b. Protects fan discharge
2. Roof Curbs:
 - a. Type: Manufacturer standard for pitched roofs, welded straight side curb with 2 inch flashing flanges and wood nailer
 - b. Mounted onto roof with fan
 - c. Material: Aluminum
 - d. Insulation thickness: 1 inch
 - e. Liner: Provide interior liner to protect insulation from air stream
 - f. Coating Type: Polyester Urethane
3. Dampers:
 - a. Type: Gravity
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with prepunched mounting holes
4. Finishes:
 - a. Type: Thermo-setting polyester urethane
5. Hinge Kit:
 - a. Aluminum hinges
 - b. Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning

PART 3 EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions.

3.02 EXAMINATION

- A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected.

3.03 PREPARATION

- A. Ensure roof openings are square, accurately aligned, correctly located,

and in tolerance.

3.04 INSTALLATION

- A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and Drawings.
- B. Install fans in accordance with manufacturer's instructions.

3.05 SYSTEM STARTUP

- A. Refer to Installation, Operation, and Maintenance Manual (IOM).

3.06 ADJUSTING

- A. Adjust exhaust fans to function properly.
- B. Lubricate bearings.
- C. Adjust drive for final system balancing.
- D. Check wheel overlap.

3.07 CLEANING

- A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction.

3.08 PROTECTION

- A. Protect installed product and finished surfaces from damage during construction.
- B. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 15837

VENTILATION FAN

PART 1 GENERAL

1.01 SCOPE

- A. This section specifies the furnishing, installation, and connection of ventilation fans for restroom applications.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with Drawings and Specifications. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, and accessories.
- C. Operation and Maintenance Data:
 - 1. Include routine maintenance, adjustment requirements, safety information, and troubleshooting guide. Contact names and information for parts and assistance shall also be provided.

PART 2 PRODUCTS

2.01 GENERAL:

- A. Ventilating fan shall be low noise wall mount type rated for continuous run.
- B. Provide Panasonic Model WhisperWall FV-08WQ1, or equal.

2.02 PERFORMANCE REQUIREMENTS

- A. Motor/Blower:
 - 1. Four-pole total enclosed condenser motor rated for continuous run.
 - 2. Power rating shall be 120VAC, 60 Hz.
 - 3. Fan shall be UL listed for tub/shower enclosure when used with a GFCI branch circuit wiring.
 - 4. Motor shall be equipped with a thermal cut-off fuse.
 - 5. Static Pressure: 0.03 inches w.g.
 - 6. Air Volume: 70 CFM

7. Noise: 1.1 sones
8. Power Consumption: 18 watts
9. Energy Efficiency: 3.9 CFM/watt
10. Speed: 660 RPM

B. Housing:

1. Rust proof paint, galvanized steel body.
2. Outside hood with built-in backdraft damper and bird screen.
3. Unit to incorporate expandable sleeve.
4. Grille shall attach directly to housing and shall be manufactured from ABS material.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive fans. Notify Engineer regarding conditions that may adversely affect installation, operation, or maintenance of fans. Proceed with installation once conditions are in accordance with manufacturer's published instructions.

3.02 PROTECTION

- A. Protect adjacent construction and finished surfaces during installation and testing.
- B. Except for operational testing, do not operate fan during construction.

3.03 INSTALLATION

- A. Install fans in accordance with Contract documents and manufacturer's published instructions.
- B. Install fan units with adequate clearances for service and maintenance.
- C. Electrical Connections: Connect wiring in accordance with NFPA 70. Provide GFCI branch circuit wiring to rate equipment suitable for use in shower area. Interface unit with switch controlling area lighting.

3.04 ADJUSTING AND CLEANING

- A. Adjust, clean, and maintain installed fan units in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL PROVISIONS

PART 1 GENERAL

1.01 SCOPE

- A. All Sections in Division 16 including installation of all materials and equipment specified in this Division.
- B. Electrical interconnection of all systems specified in other Divisions.
- C. All electrical raceways required for all systems specified and shown on the Drawings.
- D. General electrical safety equipment required for the Project.

1.02 TECHNICAL SUBMITTALS

- A. Provide technical submittals on all materials and equipment in accordance with the procedures outlined in Division 1, for approval before installation.
- B. Submit information by complete systems.
- C. Operating and Maintenance Manuals
 - 1. The materials required for each of the items in the Operating and Maintenance Manual shall consist of the following as applicable:
 - a. Manufacturer's Descriptive Literature
 - b. "Conformed to Construction" Copy of Shop Drawings
 - c. Spare Parts and Replacement Parts Lists
 - d. Manufacturer's Installation, Maintenance and Service Manuals
 - e. Description of Operation
 - f. Wiring Diagrams
 - g. Manufacturer's Guarantee and Warrantee
 - h. Test Results
 - i. Contact names and information for parts and assistance
 - 2. Materials covering more than one item shall clearly indicate which item or items are included on the project.
 - 3. Drawings which are folded and punched for insertion in the Manual shall be such that the Drawings can be unfolded without removing them from the Manual. All information shall be legible.
 - 4. The arrangement shall correspond to the specification sections of Division 16.

- D. Where material or equipment is specified by Manufacturer's catalog or model number, it is intended that equivalent materials or equipment provided by other Manufacturers will be considered for acceptance, unless otherwise noted. Latest equivalent models shall be submitted.

1.03 CODES, REGULATIONS, AND STANDARDS

- A. Codes: All work shall comply with:

1. National Electrical Code (NEC)
2. National Electrical Safety Code (NESC)
3. Local codes as applicable.
4. Other applicable National Fire Protection Association codes (NFPA)
5. Americans with Disabilities Act (ADA)

- B. Materials Testing Certifications: All basic materials and equipment shall bear the Underwriters Laboratories label of approval, or be supported by other approved testing, to assure suitability for the application. Exception to this requirement must be specifically requested and approved in writing.

- C. Standard Abbreviations

1. ANSI - American National Standards Institute
2. NEMA - National Electrical Manufacturer's Association
3. IEEE - Institute of Electrical and Electronics Engineers
4. IEC - International Electro-technical Commission
5. ICEA - Insulated Cable Engineers Association
6. OSHA - Occupational Safety and Health Administration
7. FM - Factory Mutual
8. MIL - Military Standards
9. ASTM - American Society for Testing and Materials
10. NECA - National Electrical Contractor's Association

1.04 WORK SHOWN ON DRAWINGS

- A. Some items are indicated and specified generally or in schematics without all details being shown. Provide supports, necessary hardware, conduit, and wiring.
- B. Equipment Locations: Coordinate locations of electrical work with other equipment in the area. Do not install equipment so that maintenance or operation is made difficult.
- C. Work Sequences and Removals: The Electrical Contractor must schedule electrical work to correspond with the overall project sequence. All electrical removals will be performed by the Electrical Contractor.

1.05 SPECIAL WARRANTIES

- A. Provide complete warranty information for each item. Include:
 - 1. Product or equipment list.
 - 2. Date of beginning and duration of warranty or bond.
 - 3. Names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

PART 2 PRODUCTS

2.01 EQUIPMENT PERFORMANCE

- A. Provide all accessories necessary for proper functioning of equipment provided in Division 16.

2.02 GALVANIZING

- A. Where specified in Division 16, galvanizing shall conform to the applicable standard of ASTM for hot dip galvanizing after fabrication.

2.03 WIRE AND CABLE TERMINATIONS

- A. Power terminations in Division 16 shall be suitable for 90 degrees C or 75 degrees C copper wire without de-rating from the NEC ratings.

2.04 LOCKOUT / TAGOUT CENTERS

- A. Lockout / Tagout Center A
 - 1. Provide wall mounted, multi-compartment panel, 22" x 26.5" x 4.125" (approximate) with covered bins and hanger clips.
 - 2. Equip station with the following components (minimum quantity):
 - a. Red Thermoplastic Padlocks (6)
 - b. 1" Steel Jaw Dia. Hasp (1)
 - c. Red Labeled Snap-On Hasp (1)
 - d. Adjustable Cable Lockout (1)
 - e. Compact Plug Prong Lockout (1)
 - f. Large Plug Cover (1)
 - g. Standard Toggle Universal Circuit Breaker Lockouts (4)
 - h. Tall and Wide Toggle Universal Circuit Breaker Lockouts (2)
 - i. Wall Switch Covers (2)
 - j. Rotating Gate Valve Lockout – 6-inch diameter (1)
 - k. Rotating Gate Valve Lockout – 4-inch diameter (1)
 - l. Ball Valve Handle Off Lockout (1)

- m. Moveable Dividers (5)
- n. Tags (24)
- o. Waterproof Tags (24)
- p. Ties (48)
- 3. Manufacturers:
 - a. Master Lock
 - b. Brady
 - c. Approved equal

B. Lockout / Tagout Center B

- 1. Provide compact wall mounted panel, 7.75" x 9.75" x 3.375" (approximate) with open bin and hanger clips.
- 2. Equip station with the following components (minimum quantity):
 - a. Red Thermoplastic Padlocks (2)
 - b. 1" Steel Jaw Dia. Hasp (1)
 - c. Adjustable Cable Lockout (1)
 - d. Standard Toggle Universal Circuit Breaker Lockouts (2)
 - e. Wall Switch Covers (1)
 - f. Tags (12)
 - g. Ties (12)
- 3. Manufacturers:
 - a. Master Lock
 - b. Brady
 - c. Approved equal

PART 3 EXECUTION

3.01 EXISTING STRUCTURES

- A. Repair any damage incurred in accordance with the appropriate section of these Specifications.

3.02 TESTS

- A. General: Make all required disconnections and reconnections required for performance of tests.
- B. Test Reports: Make all tests in the presence of the Owner or their representative. Submit completed test report forms to the Owner's Representative.
- C. Instruments: Provide all instruments as required.
- D. Equipment: Check for proper operation and for manufacturing defects of equipment provided in Division 16.

- E. Power Conductors through 2,000 Volts: Test circuits from 150 volts through 2,000 volts to ground and #4 AWG or larger, with a 500 volt megger, line to line and line to ground. Minimum acceptable reading: 50 megohms.
- F. Conductors over 2,000 Volts: Perform high potential tests on all insulated conductors over 2,000 volts to ground. See Cable Specification Sections for test procedures.
- G. Transformers Larger Than 75 KVA: Test resistance between windings and each winding to ground. See Transformer Specification Sections for test procedures.
- H. Control Circuit Continuity: Check all control wiring for continuity and proper terminal connections.
- I. Receptacles: Check all receptacles for proper polarity and grounding.
- J. Lighting and Power Wiring: Make tests as required to verify proper connections.
- K. Additional Tests and Inspections: As required to insure that the system is suitable to be energized. See Section on special systems for appropriate operational tests.
- L. Testing and Acceptance - General: See Div. 1 for additional information.

3.03 ADJUSTMENTS

- A. Transformers: Set all taps to obtain rated secondary voltage.
- B. Motors: Check for proper rotation, proper overload in controller, and proper motor circuit protector settings.
- C. Fuses: Check all fuses for proper rating for the application.
- D. Other: Make adjustments as required for proper operation of all systems.

3.04 MARKING AND IDENTIFICATION

- A. Implement the requirements of Section 16195 and the applicable requirements of the NEC.

3.05 SAFETY EQUIPMENT INSTALLATION

- A. Mount safety equipment in areas designated on Drawings.
- B. Avoid interference with existing proposed equipment in designated area.

3.06 WIRE AND CABLE INSTALLATION

- A. Install all conductors, in and on buildings or structures, in conduit or other appropriate raceways, unless specifically shown otherwise on the Drawings or in other Sections of these Specifications.
- B. Install electrical work as shown on the Drawings, except where changes are necessary because of physical conflicts, for improved routing, for proper operation of equipment or for other justification. When changes or deviations from the Drawings are made, the Contractor shall mark Drawings, clearly showing how the work was done.
- C. Furnish and install all sleeves, holes, core-borings, patching, slots, anchors, brackets, and supports necessary to execute the Contract Documents.

3.07 POLYCHLORINATED BI-PHENOLS (PCB)

- A. Scope: If the Contractor is required to remove or relocate transformer(s) or other equipment where PCB contamination is a possibility, perform the following:
 - 1. Test: If the equipment is not already tested and labeled, have the liquid tested and the equipment labeled by a certified testing laboratory.
 - 2. Record: Each item of equipment to be relocated and continued in service shall be labeled with an approved label: "NON-PCB" (below 50ppm), or "PCB Contaminated" (50-500ppm). Provide to the Owner a copy of the test report.
 - 3. Disposal: Items of equipment classified "PCB" (above 500ppm) shall be turned over to the Owner for disposal. Items of equipment classified "PCB Contaminated" shall be turned over to the Owner for disposal, if required by the local EPA authority.

3.08 RECORD DRAWINGS

- A. Provide at the completion of work one set of Contract Drawings showing clearly all deviations and special construction, indicating the as-built conditions.

END OF SECTION

SECTION 16015

ELECTRICAL GROUNDING

PART 1 GENERAL

1.01 SCOPE

- A. All grounding as indicated on the Drawings and as specified herein.

PART 2 PRODUCTS

2.01 ELECTRODES

- A. Rods: Copper-clad, steel core, copper bonded exterior, 3/4 inch x 10 feet minimum size.
- B. Cables: Bare Copper.

2.02 EQUIPMENT GROUNDING CONDUCTORS

- A. In Conduit: Insulated copper.
- B. Not In Conduit: #4 AWG and smaller, insulated copper. Larger than #4 AWG may be bare copper.
- C. Identification: #6 AWG and smaller, green insulation. In lieu of green insulation for sizes #4 AWG and larger, insulated grounding conductors may be identified with green tape wrap at all terminations, and at least one tape wrap per foot or part of foot in accessible enclosures. Tape shall make at least two full wraps around cable at each point.

PART 3 EXECUTION

3.01 GENERAL

- A. Install grounding systems in accordance with the NEC, NFC-780, and as indicated on the Drawings, supplemented as required by applicable local codes.

3.02 STRUCTURE ELECTRODE SYSTEMS

- A. Applicable Structures: All
- B. Method

1. Install electrode systems as indicated on the Drawings and as specified below.
 2. Top of ground rods shall be minimum 1 foot below grade.
- C. Access to Electrode Systems: Provide means to connect to the electrode system from the following as applicable:
1. Transformer secondary neutrals.
 2. Outdoor handrails.
 3. Metal equipment exposed to lightning.
 4. Building service equipment.

3.03 EQUIPMENT GROUNDING

- A. Transformers: Connect all transformer secondary neutrals.
- B. Distribution Equipment: Connect grounding busses to the respective source transformer neutral at the transformer, in the service entrance equipment, or at the first transformer secondary overcurrent protective device (separately derived systems).
- C. Equipment: Connect non-current carrying frames and enclosures to the respective source distribution grounding busses, except as otherwise specified or detailed.
- D. Conduits: Install a grounding conductor in each conduit or raceway. Size in accordance with NEC, or as indicated on the Drawings. Min. size #12 AWG. Exception: Conduits between buildings, and to light poles, where neutral must be grounded locally.
- E. Communications Backboards: Provide a #6 AWG copper wire from the serving panel board grounding bus.
- F. Light Poles: Ground light poles to local electrodes as shown on the Drawings.
- G. Equipment Exposed to Lightning: Ground fences, handrails and other metal equipment exposed to lightning directly to the structure electrode system where applicable, or to other electrodes as indicated on the Drawings.
- H. Fences: Provide a ground rod at each side of every gate, per NFC 780. Where fence is installed on non-metallic posts within 40 feet of an electric power line, provide ground rods spaced at 100 ft. intervals to approximately 100 ft. from vicinity of the power line.

3.04 CONNECTIONS

- A. Bolt grounding conductor to equipment with high copper alloy cable terminal and bolt.
- B. Bolt connectors may be used where connections are readily accessible for inspection. For hidden, buried, or concealed ground connections, use exothermic welds or approved compression connectors.

3.05 GROUND RESISTANCE MEASUREMENT

- A. Where ground resistance is specified, submit measurement readings to the Engineer. Include date, weather, and soil conditions.
- B. Method: Utilize a direct reading earth resistance tester. The tester shall be the three terminal fall-of-potential type. Make measurements as shown in the Table below. For further information see James Biddle Bulletin 25TZ or General Electric Bulletin GEJ-24D.

Electrode Width	Distance to Voltage Probe (P) (feet)	Distance to Current Probe (C) (feet)
1 ground rod	62	100
10'	100	160
20'	140	220
40'	200	320
80'	280	450
120'	340	550
200'	440	710

END OF SECTION

SECTION 16020

CONDUIT SYSTEMS

PART 1 GENERAL

1.01 SCOPE

- A. This Section applies to electrical conduit systems composed of circular section conduits and the boxes, fittings, and accessories necessary for a complete system.

1.02 REFERENCE STANDARDS

- A. Materials and galvanizing shall conform to ANSI C-80-1 (latest issue).
- B. All conduit system components shall be UL listed.

PART 2 PRODUCTS

2.01 METALLIC CONDUIT, ELBOWS, AND COUPLINGS

- A. Rigid metal (RMS) or intermediate metal (IMC) unless otherwise indicated. Galvanized rigid conduit (GRC) shall be used where specifically noted on Drawings.
- B. Electrical Metallic Tubing (EMT): may be used in protected locations above grade, but not in poured concrete. Protected locations are above dropped ceilings, in concrete block voids, stud walls, in mechanical and maintenance spaces, and in other dry spaces reasonably safe from physical damage. Process spaces are not protected locations unless indicated.

2.02 METALLIC CONDUIT FITTINGS AND MATERIALS

- A. Rigid Metal or Intermediate Metal Conduit
 - 1. Threaded type.
 - 2. Galvanized iron alloy, copper free aluminum, or galvanized malleable iron.
 - 3. Covers of same material as body.
 - 4. Covers shall be gasketed in outdoor, wet, or dusty locations.
- B. Galvanized Rigid Conduit
 - 1. Threaded type.

2. Galvanized iron alloy, or galvanized malleable iron.
3. Covers of same material as body.
4. Covers shall be gasketed in outdoor, wet, or dusty locations.

C. Electric Metallic Tubing

1. Set-screw type connectors permitted unless noted otherwise.
2. Galvanized steel or approved cast aluminum boxes and bodies.
3. Standard UL and NEC permitted.
4. Galvanized steel or aluminum covers.

D. Expansion Fitting: Linear, continuous ground type.

E. Bushings: Provide bushings or plastic inserts for conductor protection on all conduits entering boxes and enclosures, except where the box itself has built-in threaded bushings.

F. Insulated Bushings: Provide on conducts 1" and larger, where the box does not have built-in threaded bushings.

2.03 NON-METALLIC CONDUIT AND FITTINGS

A. General: For special conditions provide conduits and fittings as detailed on the Drawings.

B. Polyvinyl chloride (PVC), Schedule 80: shall be used outdoors and in wet locations, except where Fiberglass is indicated. Below grade up to 1-1/2"; larger sizes may be used above grade.

C. Polyvinyl chloride (PVC), Schedule 40: may be used indoors below grade unless otherwise noted, and above grade in protected wet locations.

D. Fiberglass Reinforced Epoxy: Shall be used outdoors below grade for pipe sizes 2" and larger. Champion SW, General Electric FRE, United Fiberglass, or equal. Minimum wall thickness 0.066"; heavier wall thickness where indicated on the Drawings. Tensile strength 11,000 psi. Temperature -40 degrees F to 230 degrees F.

2.04 FLEXIBLE CONDUIT

A. Interior Lighting and Dry Areas: Convoluted galvanized steel. Smooth interior finish. Flexible metallic tubing acceptable for lighting and other equipment in ceiling plenums.

B. General Outdoor and Process Areas: Convoluted galvanized steel core. Smooth interior finish. Bonded PVC or polyurethane jacket, with high

water and oil resistance. Jacket shall not wrinkle when conduit is bent to its minimum rated radius.

C. Grounding: Conduit and fittings shall provide electrical conductance continuity.

D. Fittings: Insulated throat type.

2.05 BOXES

A. General: "Boxes" applies to all boxes, fittings, and conduit bodies as defined in the NEC. It does not include boxes containing fixed terminal boards, control panels, or equipment enclosures.

B. Size: satisfy the requirements of the NEC, unless larger size is indicated on the Drawings. Minimum depth of receptacle boxes, 2-1/8".

C. Surface Mounted Boxes in Unfinished Areas: Cast type with appropriate covers.

D. Large Boxes In Poured Concrete: Boxes larger than 5 inches in both length and width shall be external flanged Feraloy with neoprene gasket.

E. Small Boxes In Concrete: Cast or pressed steel designed for concrete installation.

F. Outdoor: NEMA 4, with gasketed cover.

G. Identification: Each outdoor grade pull box or slab junction box larger than 5 inches square shall have the word "ELECTRIC" embossed or engraved on the cover with minimum 1/4 inch high letters.

2.06 WIREWAY

A. Manufacturers:

1. Cooper B-Line.
2. Or Equal.

B. Construction:

1. Feed-through type.
2. Wireway body and cover - minimum (14) gauge Type 304 stainless steel
3. Flanges – minimum (10) gauge stainless steel
4. Continuous welded seams, finished smooth

5. Rounded external and internal edges
6. Heavy-duty hinged covers with screw clamps mounted to the opposite side
7. Continuous flanged ends
8. Seamless poured in-place gasket on cover
9. Oil-resistant gasket for installation between flanges

C. Connector: Slip-in or Flanged.

2.07 UNDERGROUND HANDHOLE ENCLOSURES

- A. Underground handhole enclosures shall be "Quazite" enclosures as manufactured by Hubbell or equal.
- B. Unless otherwise noted, enclosures, boxes and covers shall conform to all test provisions of the most current ANSI/SCTE 77 "Specifications for Underground Enclosure Integrity" for Tier 15 applications.
- C. Enclosure sizes shall be as shown on the Drawings or larger.
- D. Covers shall be classed as "Heavy Duty" and shall be embossed as designated on the Drawings.
- E. Boxes shall be Hubbell "PG" type in configuration.

2.08 UNDERGROUND MARKER TAPE

- A. 6-inch wide bright colored, metal-backed, polyethylene plastic tape. Continuous imprinting, "CAUTION BURIED ELECTRIC LINE BELOW" or equivalent.

PART 3 EXECUTION

3.01 CONDUIT SIZE

- A. General Use: 1/2 inch minimum unless otherwise noted on Drawings.
- B. Fixture Stems: 1/2 inch.
- C. Thermostats: 1/2 inch.

3.02 ORIENTATION

- A. Parallel or perpendicular to building surfaces, unless impractical or concealed.
- B. Group whenever possible.

- C. Utilize structural members where possible to protect from physical damage.
- D. Conceal conduits in new construction finished areas such as offices, and laboratories. Do not run conduits in concrete, except for distances not more than 10 ft. for equipment connections as necessary.
- E. Locations shown on Drawings are only approximate; alternate locations may be used to avoid interferences.

3.03 CLEARANCES

- A. Walls: 1/4 inch minimum to prevent dirt and moisture accumulation.
- B. Hot Fluid Lines: 6 inch minimum.

3.04 VERTICAL DROPS

- A. In open space rigidly support from the equipment or floor structure so that the unsecured drop length does not exceed 12 ft.

3.05 SUPPORTS

- A. Intervals not to exceed NEC recommendations.
- B. Suspend conduits with rigid conduit hangers or hanger rods.

3.06 FITTINGS

- A. Insulated Metallic Bushings: Install on conduits entering boxes or cabinets, except those with threaded hubs. Provide locknuts to insure good contact to ground.
- B. Location: Install conduit access fittings (Pulling, Tee's, Ell's, and junction boxes) only where accessible. Do not exceed 270 degrees of bends in any pulling length.
- C. Expansion Fittings: Provide where conduits cross structure expansion joints.

3.07 FLEXIBLE CONDUIT CONNECTIONS

- A. Lighting: 1/2 inch minimum size: 5 ft. maximum length, above dropped ceilings.

- B. Equipment: 1/2 inch minimum size: 1'-6" to 3'-0" length.

3.08 UNDERGROUND INSTALLATIONS

- A. Encasement: Encase conduits under roadway in 3" min. concrete to 3 ft. beyond edge of roadway measured perpendicular to centerline, and in other locations indicated on Drawings.
- B. Cover
 - 1. Non-encased: minimum 36 inches below finished grade, or as otherwise noted.
 - 2. Encased: Top of concrete minimum 36 inches below finished grade.
- C. Underground Bends
 - 1. Conduits less than 3" diameter: radius 18 inches.
 - 2. Conduits 3" and larger diameter: radius 36 inches.
 - 3. Larger radius where shown on Drawings.
- D. Underground Marker Tape: Install above all conduit 12 inches below grade.

3.09 SPARE

- A. Install removable caps and markers on each end of all spare conduits. Indicate the destination of the conduit, such as column line, panel, motor control center, etc. Markers shall be adhesive-backed plastic-faced tape as manufactured by the W.H. Brady Co., or approved equal.

3.10 PREPARATION

- A. End Cuts: Cut square, ream and file to remove burrs.
- B. Field Bends: No indentations. Long axis of elliptical sections shall not exceed short axis by more than 15%.
- C. Threads: Apply conductive joint compound to metallic conduit threads.

3.11 CONCEALED CONDUIT CHECK

- A. After the conduit has been installed and before pulling in wire and cable, a standard flexible mandrel not less than 12 inches long, having a diameter of approximately 1/4 inch less than the inside diameter of the conduit shall be pulled through each conduit.

- B. Replace any conduit containing indentations or elliptical sections which the mandrel and brush cannot be pulled through, or remove any obstructions.

3.12 WIREWAY

- A. Close ends and unused openings in wireway.
- B. Provide barrier plates as required by installation.

3.13 IDENTIFICATION

- A. Label each interior junction or pull-box with both dimensions larger than five inches.
- B. Indicate the highest voltage within the box.
- C. Make label of durable materials.
- D. Secure label with stainless steel bolts or permanent adhesive.

3.14 OUTLET BOX LOCATIONS

- A. Elevation for wall-mounted outlet boxes from finished floor to center of outlet shall be as follows, except where otherwise noted:

- | | |
|----------------------|----------------------------|
| 1. Light Switches | 4'-0" |
| 2. Receptacles | 1'-6" |
| 3. Telephone Outlets | 1'-6' / 4'-6" (wall-mount) |

END OF SECTION

SECTION 16030

WIRE AND CABLE, 31V TO 2000V

PART 1 GENERAL

1.01 SCOPE

- A. Power and control systems, A-C or D-C, for voltages from 31 volts to 2000 volts line-to-ground.
- B. Does not apply to instrumentation or communication signal conductors, or other signal systems where special conductors are required.

PART 2 PRODUCTS

2.01 GENERAL

- A. Underwriters Laboratory labeled.
- B. Comply with ANSI C33.80 (UL-83).
- C. All copper shall be soft annealed per ASTM B 33-81, stranded per ASTM B 8-81.

2.02 SINGLE CONDUCTOR (600 volts)

- A. Power, No. 12 and No. 10 AWG
 - 1. Materials: Stranded copper conductor, RHW or insulation.
 - 2. Colors: Neutral-white, phase A-Black, phase B-red, phase C-blue. Other colors permissible by the NEC for special identification.
- B. Power, No. 8 to No. 4 AWG
 - 1. Materials: Stranded copper conductor, RHW insulation.
 - 2. Color: Black. (Identify phases or other distinctions with colored tape.)
- C. Power, No. 2 AWG and Larger
 - 1. Materials: Stranded copper conductor. RHW insulation.
 - 2. Color: Black. (Identify phases or other distinctions with colored tape.)
- D. Control, above 30 volts

1. Material: Stranded copper, No.14 AWG, or as otherwise indicated. THWN or THHN insulation.
2. Colors: Any colors other than green, black, red, blue, white, or other color selected for power.

E. Multi-Conductor Assemblies: Where indicated, type MC or non-metallic jacketed of the above specified conductors as noted on the Drawings.

2.03 TERMINATIONS AND SPLICES

- A. Lighting and Receptacle Circuits: Splices in No. 14, No. 12, and No. 10 AWG wire sizes may be insulated screw-on type connectors (wire nuts), with square-edge live-action spring. Ideal 451 or 452, or equal.
- B. All Others: Crimp or bolted compression type connectors, terminal lugs, and splices with insulating covering.

PART 3 EXECUTION

3.01 CONNECTIONS AND TERMINATIONS

- A. General: Install splices and taps only in junction boxes or access enclosures.
- B. Outdoor Connections: Wrap or seal cable connection with insulating tape or other means to prevent moisture entering cable.
- C. Tape Insulation: Where tape is used as the splice or connector insulation, wrap tape to 1 1/2 times the thickness of the conductor insulation.

3.02 IDENTIFICATION

- A. Identify all conductors at each terminal or splice location using pre-printed sleeves or tape for wire number or terminal number as follows:
 1. Single Phase Power: Panel and circuit number; label neutrals when more than one neutral is carried in the same conduit.
 2. Three Phase Branches and Motor Leads: L1, L2, L3, or T1, T2, T3, as applicable.
 3. Control: Cable or terminal number.

END OF SECTION

SECTION 16035

INSTRUMENT WIRE AND CABLE

PART 1 GENERAL

1.01 SCOPE

- A. Wiring to carry information, data, alarms and low energy controls. May include audio frequencies and radio frequencies.

PART 2 PRODUCTS

2.01 SCADA/COMPUTER DATA CABLE

- A. Coordinate with SCADA System Supplier.

2.02 SIGNALS

- A. Four Pair (General Purpose)

- 1. Four pair EIA-TIA568A category 5E, unshielded.
- 2. For tray or plenum dry applications, use plenum rated cables.
- 3. For underground applications in conduit use cable with wet location jacket.
- 4. Conductors: No. 24 AWG solid copper.

- B. 25 Pair (Telephone or Low Frequency Signal)

- 1. Twenty-five pair EIA-TIA568A category 3, unshielded.
- 2. For tray or plenum dry applications, use plenum rated cables.
- 3. For underground applications in conduit use cable with wet location jacket.
- 4. Conductors: No. 24 AWG solid copper.

- C. Three Pair Shielded: Where indicated. Jacket suitable for wet locations or direct burial.

PART 3 EXECUTION

3.01 CONNECTIONS AND TERMINATIONS

- A. Shield: Ground at one end only, or as recommended by the SCADA System Supplier.
- B. Terminations: Solderless lugs on screw type terminals, or plugs and jacks

as specified by the SCADA System Supplier. Terminate cables in terminal boxes provided, or equipment terminals only. Do not splice.

3.02 IDENTIFICATION

- A. Identify all cables at each terminal location using pre-printed sleeves with cable numbers as noted on the Drawings and Schedules.

END OF SECTION

SECTION 16060

SWITCHES AND RECEPTACLES

PART 1 GENERAL

1.01 SUMMARY

- A. Provide and install all equipment, labor, material, accessories and mounting hardware for a complete and operating system for the following:
 - 1. Wall switches.
 - 2. Receptacles.
 - 3. Device plates and box covers.

1.02 REFERENCES

- A. NEMA WD 1 - General Purpose Wiring Devices
- B. NEMA WD 5 - Wiring Devices, Special Purpose
- C. NEMA WD 6 - Wiring Device Configurations

1.03 SUBMITTALS

- A. Submit Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations in accordance with Section 01300.
 - 1. Submit product data on all types of wiring devices including plates and engraving.
- B. Submit Manufacturer's Instructions:
 - 1. Indicate application conditions and limitations of use stipulated by product testing agency specified under regulatory requirements.
 - 2. Include instructions for storage, handling, protection, examination, preparation, operation and installation of product.

1.04 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum five years experience.

1.05 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

as suitable for purpose specified and shown.

1.06 EXTRA MATERIALS

- A. Provide a minimum of two (2) screw drivers of each type of tamper proof screw used on project.

PART 2 PRODUCTS

2.01 GENERAL

- A. All devices shall be Specification Grade as minimum.
- B. General purpose wiring devices shall meet NEMA standard WD-1, Wiring Devices, General Purpose. Special purpose devices shall conform to the requirements of NEMA standard WD-5, Wiring Devices, Special Purpose.
- C. All wiring devices shall bear U.L. labels.
- D. All devices of one type (i.e. all snap switches, all duplex receptacles, etc.) shall be by the same Manufacturer. "Hazardous Location" and special purpose devices as may not be available from the same manufacturer shall constitute the only exception to this requirement of single source.
- E. Corrosion resistant devices shall be as specified for normal usages, and fabricated of yellow color melamine plastic. Where "Weatherproof" type is indicated for exterior or wet locations, provide matching self-closing cover, with gasketed seals at plate/wall junctions and for cover.
- F. Provide factory packaged wiring devices having high impact strength molded plastic bodies.
- G. Except where specifically required in these specifications use of interchangeable type or combination switch-receptacle-pilot devices is not acceptable, and shall be removed.

2.02 WALL SWITCHES

- A. Manufacturers:
 - 1. Single Pole Switch:
 - a. Pass & Seymour Model PS20AC1
 - b. Hubbell Model HBL1221
 - c. Leviton Model 1221
 - d. Or equal
 - 2. Double Pole Switch:
 - a. Pass & Seymour Model PS20AC2

- b. Hubbell Model HBL1222
 - c. Leviton Model 1222
 - d. Or equal
- 3. Three-Way Switch:
 - a. Pass & Seymour Model PS20AC3
 - b. Hubbell Model HBL1223
 - c. Leviton Model 1223
 - d. Or equal
- 4. Four-Way Switch:
 - a. Pass & Seymour Model PS20AC4
 - b. Hubbell Model HBL1224
 - c. Leviton Model 1224
 - d. Or equal
- 5. Single Pole Key Switch:
 - a. Pass & Seymour Model PS20AC1-L
 - b. Hubbell Model HBL1221L
 - c. Leviton Model 1221L
 - d. Or equal
- 6. Single Pole Security Locking Key
 - a. Pass & Seymour Model PS20AC1-KL-SS-717
 - b. Hubbell Model HBL1221RKL/S12RKL
 - c. Or equal
- 7. Illuminated Three-Way Switch
 - a. Pass & Seymour Model PS20AC3RPL
 - b. Hubbell Model HBL1223PL
 - c. Or equal

B. General:

- 1. Snap switches for general use shall be maintained contact types, and shall be single-pole, double-pole, three-way, or four-way as required for the specific switching arrangements shown on the drawings. They shall be quiet tumbler operation types, having silver alloy contacts, and meeting all NEMA performance standards. Color to match plates unless specifically noted otherwise in specifications and/or on drawings.
- 2. Switches shall be toggle or key-operated types, as indicated on the drawings. All key operated switches shall be keyed alike.
- 3. Where switches are denoted as having pilot lights, pilot lights shall glow when the switches are "On". Provide pilot light switch with lamp and miniature step-down transformer. The pilot light shall have a red lens, and the lamp shall be long-life type.
- 4. Jewels for use with switches controlling motors shall be green, and jewels for other purposes shall be amber. All units shall be front relampable.
- 5. Snap switches installed in hazardous locations shall be U.L. listed for

the type of location (class and division).

6. Voltage and ampere rating of switches shall be marked on switch, and shall conform to voltage of system to which applied.

C. Description: NEMA WD 1, heavy-duty, AC only general-use snap switch.

D. Voltage Rating: 120-277 volts, AC.

E. Current Rating: 20 amperes minimum.

F. Ratings: Match branch circuit and load characteristics.

2.03 RECEPTACLES

A. General:

1. All receptacles shall be of standard NEMA configuration, as indicated on the drawings, and shall comply with the respective ANSI C73 series standard for the NEMA configuration. Color to match plates unless specifically noted otherwise in specifications and/or on drawings.
2. Duplex receptacles shall have integral U.L. listed self-grounding clips. Similar, single receptacles shall be provided for plug-in connections of Industrial Fluorescent light fixtures on the same switching circuit. Receptacle face to be impact resistant nylon.
3. Weatherproof duplex receptacles shall be provided in all exterior locations, and shall be Ground Fault Circuit Interrupting (GFCI) types, with weatherproof cover plates allowing use of receptacle with cover in closed position. Covers shall be "while-in-use type, Thomas & Betts "Red Dot", or equal.
4. Special purpose receptacles for specific equipment shall be grounding types, having the number of poles, voltage and ampere ratings, and NEMA configurations required by the equipment. For each special purpose receptacle, provide an identical mating plug equipped with cord grip, secured to cord. Refer to Drawings for locations and requirements for specific configurations.
5. Duplex receptacles shall have back and side wired screw pressure terminals.

B. Description: NEMA WD 1; heavy-duty general use receptacle.

C. Convenience Receptacle: Type 5-20.

D. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

E. Manufacturers:

1. Single convenience Receptacle:
 - a. Pass & Seymour Model 5361
 - b. Hubbell Model HBL5361
 - c. Leviton Model 5351
 - d. Or equal.
2. Duplex Convenience Receptacle
 - a. Pass & Seymour Model PS5352
 - b. Hubbell Model HBL5352
 - c. Leviton Model 5352
 - d. Or equal.
3. GFCI Receptacle:
 - a. Pass & Seymour Model 2094
 - b. Hubbell Model GFR5352
 - c. Leviton Model 6898
 - d. Or equal.

2.04 COVER PLATES

- A. General: All wiring devices shall be provided with standard size one-piece cover plates of suitable configuration for the number and type of devices to be covered.
- B. Interior Switches and Receptacles: Metallic cover plates shall be used in interior spaces, except as noted below, and shall be fabricated of corrosion-resistant #302 stainless steel, having a nominal thickness of .04", and a brushed finish. Screws securing the plates shall have flush (when installed) heads with finish to match plates. Metallic cover plates shall meet all requirements of the National Electrical Code and Federal Specifications.
- C. Exterior Receptacles: Cover plates for exterior receptacles shall be metallic gasketed covers with hinge allowing plug and cord to be plugged in and activated with cover closed.
 1. Manufacturers:
 - a. Hubbell Model WP26E
 - b. Intermatic Model WP3110MXD
 - c. Or equal
- D. Exterior Switches: Cover plates for exterior switches shall be die cast metallic gasketed covers
 1. Manufacturers:
 - a. Hubbell Model RW51040
 - b. Bell Model MX1050S

c. Or equal

2.05 COLOR

- A. Wiring devices connected to normal power and located in unfinished spaces shall be gray in color.
- B. Contractor shall modify any given catalog numbers as required to procure devices and plates of the proper color.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify conditions under provisions of Division 1 - General Requirements and any other applicable supplemental requirements/conditions.
- B. Verify outlet boxes are installed at proper height.
- C. Verify wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify floor boxes are adjusted properly.
- E. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.02 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean debris from outlet boxes.

3.03 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install devices plumb and level.
- C. Install switches with OFF position down.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
- E. Do not share neutral conductor on load side of dimmers.

- F. Install receptacles with grounding pole on bottom.
- G. Install decorative plates on switch, receptacle, and blank outlets in finished areas.
- H. Electrical boxes shall be cleaned and completely free of any debris, dust, etc. prior to the installation of wiring devices.
- I. Where two or more switches or receptacles are to be installed adjacent to one another, provide a multi-gang box and combination multi-gang cover plate.
- J. Provide device cover plates for every device installed. Cover plates shall be installed so that they appear straight with no gaps between plate edges and the wall. Maintain vertical and horizontal to within 1/16 of an inch.
- K. In finished areas, provide same type of plate for all surface mounted devices as for recessed mounted devices.
- L. In any room, where new and existing construction is present, all receptacles, switches, and cover plates which are existing to remain shall be changed, as required to match new work.
- M. Wiring devices shall not be installed in exposed masonry until cleaning of masonry with acids has been completed.
- N. All receptacles and switches shall be grounded by means of a ground wire from device ground screw to outlet box screw and branch circuit ground conductor. Strap alone will not constitute an acceptable ground.
- O. All wiring devices, relays, contactors, pushbuttons, selector switches, pilot lights, etc. shall be installed in approved enclosures rated for the appropriate NEMA classified environment.
- P. All devices shall be installed so that only one wire is connected to each terminal.
- Q. Once construction is substantially completed, replace all damaged, burned, or scorched wiring devices.
- R. Receptacles shown to be floor mounted shall be installed in floor boxes (with cover plates) which are approved for this use.
- S. Connect wiring devices by wrapping conductor around screw terminal.
- T. Install galvanized steel plates on outlet boxes and junction boxes in

unfinished areas, above accessible ceilings, and on surface mounted outlets.

- U. Install protective rings and split nozzle on active flush cover service fittings.
- V. Install local room area wall switches at door locations on the lock side of the door, approximately four inches from the jamb. Where locations shown on the drawings are in question, provide written request for information to Engineer prior to rough-in.

3.04 NEUTRAL CONDUCTOR CONNECTIONS

- A. At each receptacle "in" and "out" phase and neutral conductors shall have an additional conductor for connection to device. The practice of "looping" conductors through receptacle boxes shall not be acceptable.

3.05 INTERFACE WITH OTHER PRODUCTS

- A. Coordinate locations of outlet boxes provided under other Sections of these specifications to obtain mounting heights specified and/or indicated on Drawings.

3.06 QUALITY CONTROL

- A. Inspect each wiring device for defects.
- B. Operate each wall switch with circuit energized and verify proper operation.
- C. Verify that each receptacle device is energized.
- D. Test each receptacle device for proper polarity.
- E. Test each GFCI receptacle device for proper operation.

3.07 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.

3.08 MOUNTING HEIGHT

- A. Install receptacles 18 inches above floor unless otherwise indicated.
- B. Install switches 48 inches above floor unless otherwise indicated.

END OF SECTION

SECTION 16120

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SCOPE

- A. Provide all electrical equipment disconnects shown on the Drawings and specified, except where the disconnects are furnished in another Division of the Specifications.

PART 2 PRODUCTS

2.01 DISCONNECTS

- A. Type: Fusible or non-fusible as noted on the Drawing.
- B. Voltage: 600 volts, horsepower rated at 480 volts. 250 volt rated switches, with 230 volt horsepower rating, may be provided where indicated on the Drawings.
- C. Current Rating: Amperes as noted on the Drawings, or as required for actual equipment installed. Capable of interrupting rated full load current 1,000 operations.
- D. Mechanical
 - 1. 3-pole heavy duty; quick-make quick-break.
 - 2. Visible blade; plated copper current carrying parts.
 - 3. Lugs, UL listed for 60 degrees C, aluminum or copper wires.
 - 4. Operating handle part of box, not on the cover. Position indication of ON or OFF.
 - 5. Provision for padlocking in OFF position with 3 padlocks.
 - 6. Cover interlock to prevent opening of door with switch ON, or closing of switch with door open. Screwdriver interlock defeater.
- E. Enclosure:
 - 1. Interior (non-hazardous): NEMA-1 unless otherwise indicated; or suitable for the environment.
 - 2. Interior (Class 1, Div. 1, Group D): NEMA-7 unless otherwise indicated; or suitable for the environment.
 - 3. Exterior (non-hazardous): NEMA-4X Stainless Steel unless otherwise indicated; or suitable for the environment.
 - 4. Exterior (Class 1, Div. 1, Group D): NEMA-4/7 unless otherwise

indicated; or suitable for the environment.

- F. Fuses: Unless otherwise indicated, fuses shall be dual element time delay, Class RK-5. Interrupting rating 200,000 amperes symmetrical.

2.02 CIRCUIT BREAKERS - NON-AUTOMATIC

A. General

1. For disconnects indicated larger than 200 amperes, or for motors larger than 60 horsepower, provide 3-pole non-automatic molded case (circuit breaker) switches.
2. Enclosure and operating same as for automatic circuit breaker.
3. Provision for padlocking in OFF position with 3 padlocks.
4. Cover interlock to prevent opening of door with switch ON, or closing of switch with door open. Screwdriver interlock defeater.

B. Ratings

1. Voltage: 600 volts, 60 Hz, 3 phase.
2. Current: as indicated on Drawings or 125% of equipment full load amperes.
3. Interrupting Rating: 14,000 amperes symmetrical at 480 volts.

C. Enclosure:

1. Interior (non-hazardous): NEMA-1 unless otherwise indicated; or suitable for the environment.
2. Interior (Class 1, Div. 1, Group D): NEMA-7 unless otherwise indicated; or suitable for the environment.
3. Exterior (non-hazardous): NEMA-4X Stainless Steel unless otherwise indicated; or suitable for the environment.
4. Exterior (Class 1, Div. 1, Group D): NEMA-4/7 unless otherwise indicated; or suitable for the environment.

2.03 CIRCUIT BREAKERS – AUTOMATIC

- A. Type: Molded case, with thermal and magnetic trips.
- B. Thermal Trips: Bi-metal, inverse time curve. Current as noted on the Drawings.
- C. Magnetic Trips: Approximately ten times thermal rating.
- D. Interrupting Capacity: Min. 14,000 amperes at 480 volts, or as indicated.

E. Operating Handle:

1. External on box or through cover. Three distinct positions; ON, TRIPPED, OFF.
2. Cover interlock to prevent opening of door with switch ON, or closing of switch with door open. Screwdriver interlock defeater.
3. Provision for padlocking in OFF position with 3 padlocks.

F. Enclosure:

1. Interior (non-hazardous): NEMA-1 unless otherwise indicated; or suitable for the environment.
2. Interior (Class 1, Div. 1, Group D): NEMA-7 unless otherwise indicated; or suitable for the environment.
3. Exterior (non-hazardous): NEMA-4X Stainless Steel unless otherwise indicated; or suitable for the environment.
4. Exterior (Class 1, Div. 1, Group D): NEMA-4/7 unless otherwise indicated; or suitable for the environment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Locate as indicated on the Drawings, or as convenient, comply with the NEC.
- B. Bolt units rigidly to structure with appropriate brackets, or threaded holes.
- C. On Masonry or Concrete Walls, install insulating spacers between unit and wall.

3.02 SPARE FUSES

- A. Furnish to Owner at the completion of the project, a quantity of fuses of each size and type used equal to 10% of the number installed, but not less than three of each size.

END OF SECTION

SECTION 16170

PROCESS CONTROL PANELS AND HARDWARE

PART 1 GENERAL

1.01 SCOPE

- A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all process control panels and enclosures.

1.02 RELATED SECTIONS

- A. Section 03300 - Cast-In-Place Concrete
- B. Section 16171 - Panel Mounted Instruments and Devices
- C. Section 16900 - Supervisory Control and Data Acquisition System
- D. Section 16901 - Instrumentation

1.03 RELATED EQUIPMENT SPECIFIED ELSEWHERE

- A. Section 11135 - Screen Control Panel
- B. Section 11360 - Rotary Fan Press Control Panel
- C. Section 11375 - Oxidation Ditch Control Panel

1.04 QUALITY ASSURANCE

- A. Standards, Codes and Regulations:
 - 1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
 - a. National Fire Protection Association 79, Annex "D" Standards, (NFPA).
 - b. National Electrical Code, (NEC).
 - c. National Electrical Manufacturer's Association Standards, (NEMA).
 - d. American Society for Testing and Materials, (ASTM).
 - e. Operational Safety and Health Administration Regulations, (OSHA).
 - f. Underwriters' Laboratory, Inc., (UL).
 - g. State and Local code requirements.

- h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.
2. All materials and equipment shall be new and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

B. General Design Requirements:

1. Comply with applicable sections of Division 16.

1.05 SUBMITTALS

A. Submit under provisions of Section 01300 and Section 16010.

B. Complete submittal shall be provided to the engineer for approval prior to equipment fabrication. The submittal data shall include the following:

1. Product Data - Provide product data sheets for each instrument and component supplied in the panel. The data sheets shall show the component name as used on reference drawings, manufacturer's model number or other product designator, input and output characteristics, scale or ranges selected, electrical or mechanical requirements, and materials compatibility.
2. Shop Drawings - Provide drawings for each panel showing the wiring diagrams for control circuits and interconnections of all components. The drawings shall include wiring diagrams for all remote devices connected to the panel.
3. Panel Layout Drawings - A front panel and sub-panel layout shall be included as part of each control panel drawing. Components shall be clearly labeled on the drawing.
4. Installation Drawings - Typical installation drawings applicable to each panel in the system shall be included.
5. Operator Interface - The submittal shall include a generic but detailed technical description of the Operator's Interface as proposed for each panel including:
 - a. Sample text screens and menus
 - b. Sample graphics screens

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each panel.

PART 2 PRODUCTS

2.01 GENERAL CONSTRUCTION REQUIREMENTS

- A. Provide all electrical components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.
- B. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.
- C. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 65,000 amperes RMS symmetrical at 480 Volts and 22,000 amperes RMS at less than 480 Volts, including all circuit breakers and combination motor starters. Systems of motor controllers employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL 508A labeled for the specified short circuit duty in combination with the motor branch circuit protective device.
- D. There shall be selective device coordination between the Main Breaker, Feeder Breakers and control circuit protective devices. When using a circuit breaker or fuses as a main protective device, the instantaneous trip levels of the main protective device must be higher than the available fault current to the control panel. If fuses are utilized in the control panel design, the protective devices for 3 phase loads shall contain single phase protection of such equipment. If a fault occurs in the circuit of one load of a design with a backup load, the feeder protective device should not remove both loads from the control system.
- E. Use ground fault sensing on grounded wye systems.
- F. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels".
- G. Motor controllers, including associated devices, shall be designed for continuous operation at rated current in a 40 degree C ambient temperature.
- H. Panels and enclosures shall have full front access doors.
- I. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.
- J. Provide sub-panels for installation of all relays and other internally mounted components.

- K. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.
- L. Provide copper grounding studs for all panel equipment.
- M. The bottom 12-inches of free standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing.
- N. No device shall be mounted less than 36-inches above the adjacent grade level, unless otherwise specified.

2.02 IDENTIFICATION

A. Panel Nameplates:

- 1. Engraved three-layer laminated plastic, black letters on white background unless otherwise indicated.
- 2. Locations: Each control panel or instrument enclosure.
- 3. Nameplate and Letter Size:
 - a. Identification of Panels and Enclosures: Use 1.5 inches (H) by 4 inches (W) nameplate with 1/4 inch letters.
 - b. Identification of Front-Mounted Panel Components:
 - 1) Use 1 inch (H) by 3 inches (W) nameplate with 3/16 inch letters for identifying components with a front surface area of more than 5 square inches.
 - 2) Use 1 inch (H) by 2.25 inches (W) nameplate with 1/8 inch lettering for identifying components with a front surface area of less than 5 square inches.
 - c. Provide 0.5 inch minimum spacing on each side of nameplate to allow for attachment of nameplate using stainless steel screws.

B. Wire and Terminal Markers:

- 1. Wire Markers: Self-laminating type; white labeling area with transparent polyester wrapping, such as the Brady LAT 18-361, or similar marking tape.
- 2. Text: Produced with hand-held laser printer, such as a Brady ID Pro labeler or similar device. Handwritten markings are not acceptable.
- 3. Terminal Markers: Printed labels sized to match the labeling area provided on the terminal strip. Handwritten markings are not acceptable.
- 4. Locations:
 - a. Every terminal within custom built control panels and instrumentation panels.

- b. Every wire terminated to control panel or instrumentation panel terminals.
- c. Every wire terminated to interior components of a control panel or instrumentation panel.
- d. All wiring terminated to field instrumentation.

C. Component Markers:

- 1. Description: Permanently affixed tape or engraved nameplate with 3/16 inch black lettering on white background, uniquely identifying each control device within an enclosure with a number or code corresponding to the circuit diagram.
- 2. Location: On or adjacent to each control device and visible from panel front.
- 3. Handwritten markers are not acceptable.

D. Instrument Identification Tags:

- 1. Description: Engraved three-layer laminated plastic, black letters on white background.
- 2. Locations: Each field instrument.
- 3. Nameplate and Letter Size: Use 0.75 inches (H) by 1.5 inches (W) tag with 1/8 inch lettering.

E. Nameplate Engraving and Installation:

- 1. Install nameplates above front panel-mounted components to correspond with the component that the nameplate identifies.
- 2. Engrave nameplates so that text is at the same heights on all nameplates. Variance in height should not be evident in individual nameplates mounted across the top of a row of components.
- 3. Secure nameplates to front of enclosures or panel backplanes using 20 gage, flat-head, stainless steel screws, countersunk flush with the front of the nameplate.
- 4. Where a row of front panel-mounted components deviate in size, and where the size deviation in these components requires different size nameplates, change the size and text lettering of all nameplates within the row of components to be identical.
- 5. Install nameplates and labels parallel to equipment lines.

2.03 PANELS AND ENCLOSURES

A. General:

- 1. Panels and enclosures shall meet the NEMA requirements for the type specified.

2. Sizes shown are estimates. CONTRACTOR shall furnish panels and enclosures amply sized to house all equipment, instruments, front panel mounted devices, power supplies, power distribution panels, wiring, tubing and other components installed within, as required.

B. Construction Features:

1. Control panels located inside control or electrical room areas shall be NEMA 12 rated unless otherwise designated on the Drawings.
 - a. Fabricate enclosures using minimum 14-gage steel for wall or frame mounted enclosures and minimum 12-gage for free standing enclosures. Steel shall be free of pitting and surface blemishes.
 - b. Continuously weld all exterior seams and grind smooth. Also, surface grind complete removal of corrosion, burrs, sharp edges and mill scale.
 - c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
 - d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
 - e. Use pan type construction for doors. Door widths shall not exceed 36- inches.
 - f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
 - g. Provide oil resistant gasket completely around each door or opening.
 - h. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.
 - i. Use stainless steel fasteners throughout.
 - j. Provide interior mounting panels and shelves constructed of minimum 12-gage steel with a white enamel finish.
 - k. Provide steel print pocket with white enamel finish.
 - l. Provide enclosure mounting supports as required for floor, frame, or wall mounting as required by the Drawings.
 - m. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.
 - n. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease and dirt. Zinc phosphatize for corrosion protection.

- o. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surfacer, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
 - p. All interior surfaces shall be painted with two coats of semi-gloss white polyurethane enamel.
 - q. All exterior surfaces shall be painted with a minimum of three finish coats of polyurethane enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by ENGINEER from complete selection of standard color charts furnished by the manufacturer.
 - r. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel, Hi-Solids Polyurethane B65 W300 Series as manufactured by Sherwin-Williams, Inc. or equal.
 - s. Provide one extra quart of touch-up paint for each exterior finish color.
2. Control panels located in field shall be NEMA 4X rated.
- a. Panels shall be Type 316L stainless steel construction with a minimum thickness of 12-gage for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
 - b. Stainless steel screw clamp assemblies on three sides of each door.
 - c. Rolled lip around three sides of door and along top of enclosure opening.
 - d. Hasp and staple for padlocking.
 - e. Provide interior print pocket.
 - f. Provide enclosure mounting supports as required for floor, frame, or wall mounting as required by the Drawings.
 - g. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping to enter the enclosure through the bottom, unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.

C. Electrical Systems:

- 1. Control of Environment:
 - a. Outdoor Panels:
 - 1) Where required for the operation of the components interior to the control panel, provide adequately sized automatically controlled 120 VAC strip heaters to maintain temperature inside each enclosure above 40°F to maximum of 80°F when the outside temperature is -20°F through 40° F.
 - 2) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the

maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU. Housing shall be constructed of corrosion resistant materials.

- 3) Provide thermostats to automatically control heating and cooling requirements without need of manual operation of a heating/cooling transfer switch.
- 4) Provide documentation if any of the above is deemed unnecessary.
- b. Indoor Panels:
 - 1) Provide adequately sized, automatically controlled 120 VAC strip heaters to maintain temperature 10°F above ambient for condensation prevention inside panels.
 - 2) Provide automatically controlled closed loop ventilation fans or closed loop air conditioners with filtered air louvers if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the enclosure. Air conditioner shall have a minimum capacity of 4,000 BTU.
 - 3) Provide documentation if any of the above is deemed unnecessary.
2. Power Source and Internal Power Distribution:
 - a. General: Control panel power supply source, type, voltage, number of circuits and circuit ratings shall be as shown on the Drawings or as outlined in the Specifications.
3. Wiring:
 - a. Internal wiring shall be Type MTW and THW stranded copper wire with thermoplastic insulation rated for 600 V at 90°C for single conductors, color coded and labeled with wire identification.
 - b. For DC panel signal wiring, use No. 18 minimum AWG shielded.
 - c. For DC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 16 minimum AWG. For wiring carrying more than 15 A, use sizes required by NEC standards.
 - d. Separate and shield low voltage signal wiring from power and control wiring by a minimum of 6-inches.
 - e. Group or bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1-inch. Troughs shall have 40 percent spare capacity.
 - f. Install wire troughs along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.
 - g. Adequately support and restrain all wiring runs to prevent sagging or other movement.
 - h. Terminate all field wiring using forked, insulated, crimp-on connectors (soldered type not acceptable) at 600 V rated barrier type terminal strips with screwed connections and permanently affixed numeric identifiers beside each connection. Identifiers to be

self-stick plastic tape strips with permanent type, machine printed numbers. For DC field signal wiring, terminal strips shall be capable of handling No. 12 wiring (minimum). Provide Phoenix Contact, Entrelec, Allen Bradley, or equal.

- i. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
 - j. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to terminal blocks.
 - k. For internal component-to-component wiring only, compression type terminal blocks are acceptable.
 - l. Provide spare terminals equal in number to 20 percent of the terminals used for each type of wiring (e.g., DC signal and AC power).
 - m. Provide a separate terminal for grounding each shielded cable.
 - n. Use separate 5/16-inch diameter copper grounding studs for instrument signal cable shields and AC power.
 - o. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
 - p. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
 - q. Provide circuit breakers to protect each circuit, with no more than six instruments on a single circuit.
 - r. Provide complete wiring diagram showing "as-built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.
4. Surge Protection:
- a. General: Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in suitable metallic cases, properly grounded. Ground wires for all surge protectors shall be connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.
 - b. The units shall be as manufactured by Telecommunication Industries, Inc., Joslyn, or equal.

2.04 CONTROL PANELS WITH MOTOR STARTERS / VFD's

- A. Provide NEMA 12 enclosures for indoor applications and NEMA 4X 316 stainless steel enclosures for all other applications unless otherwise

noted.

- B. Control panels shall be produced by a UL 508A control panel shop. The control panels shall qualify for and be labeled with a UL 508A label. The label shall state the short circuit current rating (SCCR) of the control panel as determined in accordance with Part SB of UL 508A. The minimum SCCR rating required are:
 - 1. 42 KA for control panels with a 480 Volt power input.
 - 2. 14 KA for control panels with a power input of less than 480 Volts.
- C. Provide a main circuit breaker for each control panel: Main circuit breaker shall:
 - 1. Be of the thermal magnetic type.
 - 2. Have the required AIC rating to achieve the SCCR rating called for by the voltage rating of the control panel.
 - 3. Have a mechanism added to the circuit breaker to operate its on/off handle via a flexible cable operating mechanism attached to the enclosure flange-mounted operator handle as described for the enclosure.
 - 4. Have lightning arrestor on the line side of the main circuit breaker for surge protection. Mount lightning arrestor inside of NEMA 1 box inside of control panel enclosure to protect against destructive failure of lightning arrestor should this occur. Lightning arrestors shall be Delta Lightning Arrestor, Big Spring TX, model LA 303 or approved equal.
- D. Where control panels are indicated to incorporate motor starters, provide combination motor starters for each motor to be powered from the panel. Combination motor starters shall:
 - 1. Be fed from the control panel main circuit breaker
 - 2. Consist of a thermal magnetic circuit breaker, a NEMA rated and sized contactor and an overload unit to provide a full voltage, across-the-line starter for each pump at the pump station unless otherwise noted. NEMA Size 1 contactors shall be the minimum size provided. Overload unit shall have a calibrated adjustment dial, calibrated in amperes, for adjusting the setting of the unit. Unit shall be set to trip at 1.25 times the full load amps (FLA) of the pump motor for motors with a marked service factor of not less than 1.15 or motors with a temperature rise of 40°C or less. For all other motors, set unit to trip at 1.15 times the motor FLA. Unit shall be either ambient compensated or ambient insensitive.

- E. Where control panels are indicated to incorporate variable frequency drives (VFD's), provide VFD's for each motor to be powered from the panel. VFD's shall be as outlined in Section 16425.
- F. Control power shall be provided from within the control panel. Control power shall:
 - 1. Be 120V AC
 - 2. Be from an internal control power transformer located downstream of the main circuit breaker sized for the VA rating of the electrical items powered by it. Provide two fuses on the primary side of the control power transformer and one fuse in the ungrounded leg on the secondary side of the transformer.
 - 3. Power the motor space heater inside of each motor that the control panel powers. The control power transformer shall provide this 120 volt power. The motor space heater power shall be switched by a relay circuit that energizes the heater only during periods of motor inactivity.
- G. Relays, timers and internal control wiring shall be as specified in Section 16171, Panel Mounted Instruments and Devices.
- H. Provide the control panel switches, lights, time delays, discrete and analog input and output signal provisions and other control items as shown on the instrumentation and electrical drawings. As a minimum, the control panels shall have the following items for each motor:
 - 1. Red run light indicating that the motor is operating
 - 2. Green stopped light indicating that the motor is stopped
 - 3. Amber common alarm light indicating the presence of an alarm. Alarms shall remain latched until reset.
 - 4. Elapsed time meter (hour meter)
 - 5. Discrete run contacts that close when motor is running.
 - 6. Discrete alarm contacts that open when the motor experiences any alarm condition.
- I. Provide a print pocket on the inside of the control panel door. Place a plastic laminated copy of each manufacturer drawing for the control panel in the print pocket.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install equipment in conformance with NEC.
- B. Unless otherwise noted, wall-mount indoor panels.

- C. Unless otherwise noted, install outdoor panels on support structure with reinforced concrete housekeeping pad as shown on the Drawings:
- D. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.02 TESTING AND ADJUSTMENTS

- A. Perform system testing and make any adjustments necessary in accordance with this Section.
- B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

3.03 PANEL SCHEDULE

A. Post Air Blower Local Control Panel

Panel:	Post Air Blower Local Control Panel				
Location:	UV Area Electric Service Panel				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	20A / 3P				
<u>Motor Control:</u>					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	Post Air Blower	5	Motor Starter	HOA	R, G, A ₁ , A ₂ , RTM
<u>Equipment Control Interface:</u>					
	<u>Description</u>				<u>Type</u>
	Post Blower High Pressure (alarm condition - A ₁)				DI
	Post Air Blower High Temperature (alarm condition - A ₂)				DI
<u>SCADA Interface:</u>					
	<u>Description</u>				<u>Type</u>
	Panel Power Fail				DO
	Blower Run				DO
	Blower HOA Position				DO
<u>Panel Control Logic:</u>					
-	In "AUTO" Blower operates based upon a 24-hour timer.				
-	Timer sequence is set by Operator at LCP.				
-	Timer shall incorporate option for a minimum of three (3) operational periods in a 24-hour period.				

B. Clarifier Local Control Panel

Panel:	Clarifier Local Control Panel				
Location:	Clarifier Electric Service Panel				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	20A / 3P				
<u>Motor Control:</u>					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	Clarifier #1	1/2	Motor Starter	On/Off	R,G,A
	Clarifier #2	1/2	Motor Starter	On/Off	R,G,A
<u>Equipment Control Interface:</u>					
	<u>Description</u>	<u>Type</u>			
	Clarifier #1 – 100% Torque (alarm)	DI			
	Clarifier #1 – 100% Torque (alarm/shutdown)	DI			
	Clarifier #2 – 100% Torque (alarm)	DI			
	Clarifier #2 – 100% Torque (alarm/shutdown)	DI			
<u>SCADA Interface:</u>					
	<u>Description</u>	<u>Type</u>			
	Panel Power Fail	DO			
	Clarifier #1 - Run	DO			
	Clarifier #1 – High Torque	DO			
	Clarifier #1 – Torque Overload	DO			
	Clarifier #2 – Run	DO			
	Clarifier #2 – High Torque	DO			
	Clarifier #2 – Torque Overload	DO			
<u>Panel Control Logic:</u>					
-	Clarifier equipment is manually actuated at the LCP by the operator by turning the motor control to the “ON” position.				

C. Digester Blower Local Control Panel

Panel:	Blower Control Panel				
Location:	Blower Electric Service Panel				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	100A / 3P				
<u>Motor Control:</u>					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	Sludge Blower #1	20	VFD	HOA	R, G, A1, A2, RTM
	Sludge Blower #1	20	VFD	HOA	R, G, A1, A2, RTM
	Sludge Blower #3	20	VFD	HOA	R, G, A1, A2, RTM
	Sludge Transfer Pump	2	VFD	HOA	R, G, A, RTM

<u>Equipment Control Interface:</u>		
	<u>Description</u>	<u>Type</u>
	Sludge Transfer Pump Over Temperature (alarm / shutdown)	DI
	Sludge Transfer Pump Over Temperature (alarm / shutdown)	DI
	Blower #1 High Pressure (alarm condition - A1)	DI
	Blower #1 High Temperature (alarm condition - A2)	DI
	Blower #2 High Pressure (alarm condition - A1)	DI
	Blower #2 High Temperature (alarm condition - A2)	DI
	Blower #3 High Pressure (alarm condition - A1)	DI
	Blower #3 High Temperature (alarm condition - A2)	DI
	Sludge Transfer Float Controls (2) (Off - Low Level Alarm / On)	DI
<u>SCADA Interface:</u>		
	<u>Description</u>	<u>Type</u>
	Panel Power Fail	DO
	Blower #1 Run	DO
	Blower #1 HOA Position	DO
	Blower #2 Run	DO
	Blower #2 HOA Position	DO
	Blower #3 Run	DO
	Blower #3 HOA Position	DO
	Sludge Transfer Pump Run	DO
	Sludge Transfer Pump HOA Position	DO
	VFD #1 Fault	DO
	VFD #2 Fault	DO
	VFD #3 Fault	DO
	Sludge Transfer VFD Fault	DO
	Sludge Transfer Pump Speed Required	AI
	Sludge Transfer Pump Speed Feedback	AO
	Sludge Low Level Alarm	DO
	Sludge Level "High"	DO
	Common Blower High Temperature	Do
<u>Panel Control Logic:</u>		
-	Blower operation is manually initiated by the operator by placing a Blower in "HAND" or "AUTO".	
-	Only two (2) blowers shall be permitted to operate at the same time. An interlock shall be provided to prevent simultaneous operation of three blowers.	
-	Sludge Pump target operation speed is received from the Sludge Press via SCADA.	
-	Blower speed (#1, #2, #3) is set locally by operator via interface with respective VFD's.	
-	Sludge transfer pump is controlled via interface with Sludge press (remote). Operational speed of pump is modulated based on sludge rate requested. Sludge Transfer float controls serve as back-up controls for pump "Off" operation.	
-	Sludge Transfer Pump "ON" float is utilized to signal that adequate sludge is available for Sludge Transfer Pump to operate.	

D. Influent Pump Local Control Panel

Panel:	Influent Pump Local Control Panel				
Location:	Pump Building – Main Level				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	50A / 3P				
<u>Motor Control:</u>					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	Influent Pump #1	7.5	VFD	HOA	R,G,A, RTM
	Influent Pump #2	7.5	VFD	HOA	R,G,A, RTM
	Influent Pump #3	15	Motor Starter	HOA	R,G,A, RTM
<u>Equipment Control Interface:</u>					
	<u>Description</u>	<u>Type</u>			
	Influent Pump #1 Over Temperature (alarm / shutdown)	DI			
	Influent Pump #1 Leakage Sensor (alarm / shutdown)	DI			
	Influent Pump #2 Over Temperature (alarm / shutdown)	DI			
	Influent Pump #2 Leakage Sensor (alarm / shutdown)	DI			
	Influent Pump #3 Over Temperature (alarm / shutdown)	DI			
	Influent Pump #3 Leakage Sensor (alarm / shutdown)	DI			
	Backup Floats (5 Float System)	DI			
	Wet Well Level	AI			
	Visual Alarm Light (high level)	DO			
	Audible Alarm Siren (with silencer) (high level)	DO			
<u>SCADA Interface:</u>					
	<u>Description</u>	<u>Type</u>			
	Panel Power Fail	DO			
	VFD #1 Fault	DO			
	VFD #2 Fault	DO			
	Influent Pump #1 Run	DO			
	Influent Pump #1 HOA Position	DO			
	Influent Pump #2 Run	DO			
	Influent Pump #2 HOA Position	DO			
	Influent Pump #3 Run	DO			
	Influent Pump #3 HOA Position	DO			
	High Water Alarm	DO			
<u>Panel Control Logic:</u>					
-	Pump operation based upon the level within the wet well.				
-	Pump speed is paced to match level in wet well reported via level transducer. Lead Pump (of 7.5 HP pumps) initiates operation at 40 Hz at set level and ramps to 60 Hz. Continuing level rise engages Lag Pump (7.5 HP). Continuing level rise engages Pump #3 and drops operation of Lead Pump. Level drop to "Lag" level drops operation of Pump #3. Low level drops Lag Pump (or Lead Pump if Lag Pump was not engaged as a part of sequence).				
-	Alternation sequence Between Pump #1 / Pump #2 shall be Operator selectable and/or shall be based upon least run time.				
-	Float system serves as back-up to level transducer.				

E. River Pump Station Local Control Panel

Panel:	River Pump Local Control Panel				
Location:	UV Area Electric Service Panel				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	30A / 3P				
<u>Motor Control:</u>					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	River Pump #1	5	Motor Starter	HOA	R,G,A,RTM
	River Pump #2	5	Motor Starter	HOA	R,G,A,RTM
<u>Equipment Control Interface:</u>					
	<u>Description</u>	<u>Type</u>			
	River Pump #1 Over Temperature (alarm / shutdown)	DI			
	River Pump #1 Leakage Sensor (alarm / shutdown)	DI			
	River Pump #2 Over Temperature (alarm / shutdown)	DI			
	River Pump #2 Leakage Sensor (alarm / shutdown)	DI			
	Float Controls (4) (Off / Lead On / Lag On / High Level Alarm)	DI			
	Visual Alarm Light (high level)	DO			
	Audible Alarm Siren (with silencer)(high level)	DO			
<u>SCADA Interface:</u>					
	<u>Description</u>	<u>Type</u>			
	Panel Power Fail	DO			
	Pump #1 Run	DO			
	Pump #1 HOA Position	DO			
	Pump #2 Run	DO			
	Pump #2 HOA Position	DO			
	High Level Alarm	DO			
<u>Panel Control Logic:</u>					
-	Station is "Normally Off". Operator engages electrical service to LCP manually based on river level.				
-	Alternation sequence shall be Operator selectable				
-	Pumps operate in a Lead/Lag configuration.				

F. RAS Pump Station Local Control Panel

Panel:	RAS Pump Station Local Control Panel				
Location:	RAS Pump Station Electric Service Panel				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	60A / 3P				
Motor Control:					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	RAS Pump #1	5	Motor Starter	HOA	R,G,A,RTM
	RAS Pump #2	5	Motor Starter	HOA	R,G,A,RTM
	RAS Control Valve	Fractional	Feeder	On/Off	
	WAS Control Valve	Fractional	Feeder	On/Off	
Equipment Control Interface:					
	<u>Description</u>	<u>Type</u>			
	RAS Pump #1 Over Temperature (alarm / shutdown)	DI			
	RAS Pump #1 Leakage Sensor (alarm / shutdown)	DI			
	RAS Pump #2 Over Temperature (alarm/shutdown)	DI			
	RAS Pump #2 Leakage Sensor (alarm/shutdown)	DI			
	Float Controls (4) (Off/Lead On/Lag On/High Level Alarm)	DI			
	Visual Alarm Light (high level)	DO			
	Audible Alarm Siren (with silencer) (high level)	DO			
SCADA Interface:					
	<u>Description</u>	<u>Type</u>			
	Panel Power Fail	DO			
	Effluent Flow Rate	AI			
	VFD #1 Fault	DO			
	VFD #2 Fault	DO			
	RAS Pump #1 Run	DO			
	RAS Pump #1 HOA Position	DO			
	RAS Pump #2 Run	DO			
	RAS Pump #2 HOA Position	DO			
	High Water Alarm	DO			
Panel Control Logic:					
-	Pump speed is set via the VFD based upon the effluent flow rate from the WWTP.				
-	Alternation sequence shall be Operator selectable and/or shall be based upon least run time.				
-	Pumps operate in a Lead/Lag configuration.				

G. Compost Blower Local Control Panel

Panel:	Compost Blower Local Control Panel				
Location:	Compost Blower Electric Service Panel				
Voltage:	480V / 3Ø / 3W				
Main Circuit Breaker:	15A / 3P				
<u>Motor Control:</u>					
	<u>Description</u>	<u>HP</u>	<u>Type</u>	<u>Controls</u>	<u>Accessories</u>
	Compost Blower	2	Motor Starter	On/Off	R, G, RTM
<u>Equipment Control Interface:</u>					
	<u>Description</u>				<u>Type</u>
<u>SCADA Interface:</u>					
	<u>Description</u>				<u>Type</u>
	Panel Power Fail				DO
	Blower Run				DO
<u>Panel Control Logic:</u>					
-	Blower equipment is manually actuated at the LCP by the operator by turning the motor control to the "ON" position.				

END OF SECTION

SECTION 16171

PANEL MOUNTED INSTRUMENTS AND DEVICES

PART 1 GENERAL

1.01 SCOPE

- A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation panel instruments and devices.
- B. Contract Documents illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Contractor shall provide all piping, wiring, accessories and labor required for a complete, workable and integrated system.
- C. Coordination: Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.02 QUALITY ASSURANCE

- A. Acceptable Manufacturers:
 - 1. Furnish instruments and devices by the named manufacturers or equal equipment by other manufacturers.
 - 2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
 - 3. Obtain all instruments or devices of a given type from the same manufacturer.
- B. Manufacturers' Responsibilities and Services:
 - 1. Design and manufacture the instruments and devices in accordance with the applicable general design requirements and the detailed Specifications herein.
 - 2. Provide field supervision, inspection, start-up and training in accordance with the General Requirements and as outlined herein.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300.

- B. Complete submittal shall be provided to the Engineer for approval prior to equipment fabrication. The submittal data shall include the following:
 - 1. Product Data - Provide product data sheets for each instrument and component supplied. The data sheets shall show the component name as used on reference drawings, manufacturer's model number or other product designator, input and output characteristics, scale or ranges selected, electrical or mechanical requirements, and materials compatibility.

PART 2 PRODUCTS

2.01 POWER SUPPLIES

- A. General: Single unit and multiple unit power supplies, located in control room panels, remote terminal units and field panels as required.
- B. Required Features:
 - 1. Solid state circuitry.
 - 2. Standard 19-inch RETMA (EIA) rail mounting.
 - 3. Input Power: 120 VAC \pm 10 percent, 60 Hz.
 - 4. Output Power: 24 VDC or as required.
 - 5. Polarity: Floating output.
 - 6. Ambient Temperature: -10°C to +71°C.
 - 7. Response Time: <20 μ S.
 - 8. Include over-voltage protection, output current limiting protection, provisions for paralleling power supplies and front panel mounted indicating fuses.
 - 9. If the power supplies are connected in parallel, provide isolation diodes in series with the positive lead of each of the parallel connected power supplies.
 - 10. Connections:
 - a. Twist-lock AC power connector.
 - b. DC power terminal strip.
- C. Products and Manufacturers: Provide one of the following:
 - 1. Phoenix Contact, Quint series.
 - 2. Sola
 - 3. Or equal.

2.02 UNINTERRUPTIBLE POWER SYSTEM

- A. Uninterruptible Power System (UPS) shall be furnished to provide a reliable source of uninterruptible power with no break in AC output power

during a complete or partial interruption of incoming line power. UPS shall include audio/visual alarms. UPS shall be UL listed.

- B. Rating: 120 VAC, 60 Hz, provide the minimum recommended kVA ratings to provide uninterrupted conditioned power, fully loaded conditions for 15 minutes. The Contractor shall confirm UPS ratings per submitted load calculations and per spare capacity and runtime requirements as specified herein.
- C. Description: On line dual track power conditioner and true (0 ms transfer time) uninterruptible power supply providing isolation, line regulation and conditioning, using sealed 48 VDC maintenance free batteries and switch mode power supply for uninterrupted power with 0.5 to 0.7 power factor and 2.7 to 3.5 crest factor.
- D. Required Features:
 - 1. Lighting and Surge Protection: Inherent 2000: One spike attenuation.
 - 2. Regulation: One to three percent load regulation with less than 2pF effective coupling capacitance for line to load.
 - 3. Output Waveform: Computer grade sine wave with three percent maximum single harmonic and five percent maximum total harmonic distortion.
 - 4. Output Frequency: 60 Hz \pm 0.5 Hz.
 - 5. Operating Temperature: 1°C to 40°C.
 - 6. Relative Humidity: Five to 90 percent non-condensing.
 - 7. Computer Interface: RS232 port for display of 22 meter functions and 15 alarm functions.
 - 8. Alarm Outputs: As a minimum provide "Battery Low" and "UPS Fail" alarm outputs. Contact rating should not be less than 3 A resistive at 120 VAC.
 - 9. Input Protection: Independent battery charger fuse and DC fuses.
 - 10. Output Protection: Inherently current limited ferro-resonant transformer.
 - 11. Battery Charger: Two-step charger, 8 A and 2 A.
 - 12. AC Input: 120 VAC, 60Hz, single phase, +15 percent, -20 percent.
 - 13. AC Output: 120 VAC, 60Hz, single phase, +3 percent, -3 percent.

- E. Products and Manufacturers: Provide one of the following:

- 1. APC.
- 2. Eaton.
- 3. Or equal.

2.03 SURGE PROTECTION AND SUPPRESSION DEVICES

- A. Definitions:

1. TVSS: Transient Voltage Surge Suppressor.
2. SPD: Surge Protection Devices.

B. Codes and Reference Standards:

1. The TVSS / SPD shall comply with the following standards:
 - a. UL Listed or recognized to UL 1449, 3rd edition.
 - b. Application Guide A and IEEE C62.41.1-2002 Category C area.
 - c. IEC 61024/Application Guide A.
 - d. National Electrical Code.
 - e. IEC 61643-1.

C. General:

1. The TVSS / SPD shall be available in a non-enclosed Din rail mounted version or mounted in a suitable enclosure.
2. The TVSS / SPD components can be either a self-contained wired in unit or a modular unit with field replacement capability without the removal of any wires.
3. TVSS/ SPD for 4-20ma shall be available in either series or parallel connection depending on the application.
4. The TVSS/ SPD shall be capable of supporting local and or remote alarming for failure notification.

D. Main Power Panel Requirements:

1. Facility incoming voltage of 3 phase 480/277 AC or 3 phase 120/240 AC will require TVSS/ SPD protection with the following requirements:
 - a. 50 KA per IEC 61024 or 100 KA each phase per ANSI/IEEE C62.41.
 - b. MOV, Arc Chute or Hybrid technology is acceptable.
 - c. Response time: $1 < \text{nanosecond}$ or di/dt rise for lightning strikes.
 - d. Din Rail mounted or suitable enclosure.
 - e. Multi-modes of protection (minimum L, N, and G).
2. Manufacturer:
 - a. Surge Suppression Incorporated.
 - b. Dehn, Dehnguard.
 - c. Phoenix Contact.
 - d. Or equal.

E. Secondary Power Panel Requirements:

1. Secondary power panels supplying power to single phase 120/ 240 VAC or 120 VAC systems will require TVSS/ SPD protection with the following requirements:

- a. 40 KA each leg per ANSI/ IEEE.
- b. MOV or Hybrid technology is acceptable.
- c. Response time: <1 nanosecond.
- d. Din Rail mounted or suitable enclosure.
- 2. Manufacturer:
 - a. Surge Suppression Incorporated, Advantage SKLA-1S1.
 - b. Dehn, Dehnguard Series.
 - c. Phoenix Contact.
 - d. Or equal.

F. 4-20 mA Instrumentation Loops:

- 1. Surge current rating of 10 KA per ANSI/ IEEE.
- 2. The TVSS/ SPD must be base with interchangeable circuit protection.
- 3. Din Rail mounted.
- 4. Shall have means for field testing.
- 5. Manufacturer:
 - a. Surge Suppression Incorporated.
 - b. Dehn, Blitzductor.
 - c. Phoenix Contact.
 - d. Or equal.

G. Installation and Wiring:

- 1. Wire length between the TVSS/ SPD and ground should be as short as possible, straight with no or minimum radius bends.
- 2. Grounds shall be 1 ohm or less impedance.
- 3. Wire length between the protected device and the TVSS/ SPD should be as short as possible, straight with no or minimum radius bends.

H. Testing Requirement:

- 1. Vendor shall provide verifiable third party test results of the stated specification of TVSS/ SPD.

I. Warranty:

- 1. 5 Year unlimited, free replacement unit or replacement parts for all Malfunctioning TVSS/ SPD devices.

J. Listed manufacturers or approved equal:

- 1. Phoenix Contact.
- 2. Surge Suppression, Inc.
- 3. Or equal.

2.04 ALTERNATOR RELAYS

A. Manufacturers:

1. Diversified Electronics
 - a. Duplexer, Model ARB-120
 - b. Expandable, Model ARA-120-A-Z
2. Syrelec
 - a. Duplexer, Model LJR25
 - b. Triplex, Model FJR3
3. Or equal

B. Description: Solid state alternator relay switch selectable.

C. Contact Ratings: 10 AMP, 120V.

D. Coil Voltage: 120 volts, 60 Hz.

E. Socket: DIN rail mounted with screw terminals.

F. Operation: Load one locked, load two locked alternate.

2.05 MOTOR PROTECTOR RELAYS

A. Manufacturers:

1. Diversified Electronics Model SLA 440-ASA
2. Time Mark Model A257B
3. SSAAC Model PLM9405.
4. Square D, Model MPD
5. Or equal

B. Description: Solid state Three Phase Power Monitor

C. Contact Rating: Min. of 10A , 120 V

D. Operating Voltage: 480 volt 3 phase, unless noted otherwise.

E. Socket: May be DIN rail mounted, terminals to be " finger safe" and rated for 480 volt min.

F. Operation: Relay shall open the control circuit of the protected device on under voltage, phase reversal, phase unbalance, loss of phase. Relay shall have an adjustable trip point.

2.06 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

A. General:

1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or model type.
2. Type:
 - a. Heavy duty, oil tight.
3. Provide legend plate for indication of switch, pushbutton or light function (e.g., "OPEN-CLOSED", "HAND-OFF-AUTO").
4. Mounting: Flush mounted on control panel front, unless otherwise noted.
5. NEMA rated to match panel in which mounted.

B. Selector Switches:

1. Type: Provide selector switches with number of positions as required to perform intended functions as shown and specified.
2. Contacts:
 - a. Provide number and arrangement of contacts as required to perform intended functions specified, but not less than one single pole, double throw contact.
 - b. Type: Double break, silver contacts with movable contact blade providing scrubbing action.
3. Rating: Compatible with AC or DC current with devices simultaneously operated by the switch contacts, but not less than 10 A resistive at 120 VAC or DC continuous.
 - a. Switch Operator: Standard black knob.

C. Pushbuttons (Standard or Illuminated):

1. Type: Provide momentary lighted and/or unlighted, single and/or dual type pushbuttons as required to perform intended functions specified and shown.
2. Contacts: Comply with the requirements specified for selector switches.

D. Indicating Lights:

1. Type: Compact, integral transformer type.
2. Lamps: Low voltage, long life LED.

E. Button and Lens Colors:

1. Red (R) for indication of open, on, running.
2. Green (G) for indication of closed, off (ready), stopped.
3. Amber (Y) for indication of equipment malfunction, process trouble and alarms (e.g., "HIGH LEVEL", "LOW LEVEL", etc.).
4. White (W) for indication of electrical control power on.

F. Products and Manufacturers: Provide one of the following:

1. Cutler-Hammer, Type E30.
2. Allen Bradley, Series 800.
3. Or equal.

2.07 DIN RAIL MOUNTED ETHERNET PATCH PANEL

A. General:

1. Provide DIN Rail mountable RJ-45 CAT6 patch panel for termination of Ethernet cabling from field and within control panel enclosures as shown on the Drawings.

B. Manufacturer and Model:

1. Phoenix Contact.
2. Or equal.

2.08 DIGITAL INDICATOR

A. General: The digital indicator shall accept an analog input and convert it to scaled numerical characters for digital display and also provide up to two alarm outputs.

B. Required Features:

1. Display Height: 0.56-inch.
2. Display Capacity: Four digits with decimal point position jumper selectable.
3. Display Type: Seven segment, red LED.
4. Accuracy: ± 0.05 percent.
5. Analog Input: 4 to 20 mADC.
6. Excitation Output: 15 VDC for powering transmitter.
7. Analog Output: Proportional 4 to 20 mADC.
8. Alarm Output: Dual with two 2 A relays.
9. Temperature Range: 0°C to 60°C.
10. Power: 120 VAC, + 10 to -15 percent, five watts.
11. Enclosure: NEMA 4 splash proof.

C. Products and Manufacturers: Provide one of the following:

1. Newport Electronics, Model Q9000E.
2. Precision Digital, Model PD690.
3. Or equal.

2.09 ELAPSED TIME METER (RTM)

A. General: Unit shall be a powered, non-resettable time indicator, with easy to read analog figures.

B. Required Features:

1. Power: 24 VDC or 120 VAC, as required.
2. Accuracy: Within one percent.
3. Capacity: Up to 99,999.9 hours (automatic recycle at zero); one-tenth hour resolution.
4. Operating Temperature: -40°C to +68°C.
5. Sealed against dirt and moisture.
6. Tamperproof.
7. Shock resistant.
8. Panel mountable.
9. Nameplate below display shall read "TOTAL HOURS".

C. Products and Manufacturers: Provide one of the following:

1. Dynapar/Veeder-Root, 7795 Series.
2. Cutler-Hammer, E42DIR Series.
3. Or equal.

2.10 MAGNETIC CONTROL RELAYS

A. Manufacturers:

1. Allen-Bradley, Bulletin 700, Model H
2. Square D, Model 8501, Type K
3. Struthers-Dunn 219, 14-pin (6 pole, NO)
4. Or equal.

B. Magnetic Control Relays: NEMA ICS 2, Class A300.

C. Contacts: NEMA ICS 2, Form C, Three pole double throw.

D. Contact Ratings: NEMA ICS 2, 10A @ 240 Vac.

E. Coil Voltage: 120 volts, 60 Hz., AC.

F. Operator: Manual Operator.

G. Sockets: DIN rail mounting and screw terminals.

2.11 CONTROL RELAY

A. Type: General purpose, plug-in type rated for continuous duty.

B. Construction Features:

1. Coil Voltages: 24 VDC or 120 VAC, as required.
2. Contacts:
 - a. Silver cadmium oxide rated not less than 10 A resistive at 120 VAC or 24 VDC continuous.
 - b. For switching low energy circuits (less than 200 mA) fine silver, gold flashed contacts rated not less than 3 A resistive at 120 VAC or 28 VDC continuous shall be provided.
3. Mounting: Pin or blade mount in sockets for sub-panel mounting on DIN rail. Sockets shall have screw terminals for wiring connections which shall accept a minimum of two No. 14 AWG wires.
4. Relays to have clear plastic dust cover.
5. Relays to have pilot light to show energized coil.
6. Relays to be UL recognized.

C. Products and Manufacturers: Provide one of the following:

1. Square D Company, Type R and/or Type K.
2. IDEC, RU Series.
3. Or equal.

2.12 TIME DELAY RELAY

- A. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break or interval operation.

B. Construction Features:

1. MOS digital circuit with transformer coupled power.
2. Switch selectable ranges as follows:
 - a. One second
 - b. Ten seconds.
 - c. One minute.
 - d. Ten minute.
 - e. One hour.
 - f. Ten hours.
3. Minimum Setting: Three percent of range, except 50 ms for one-second range.
4. Setting Knob Accuracy: Ten percent.
5. Contacts:
 - a. Type: DPDT.
 - b. Rating: 5 A resistive at 120 VAC, 5 A at 24 VDC.
6. Housing: Plug-in design with dust and moisture resistant molded plastic case.

7. Power Input: 120 VAC or 24 VDC as required.
8. Operating Temperature: 0°C to 55°C.
9. Unit shall have LED to show timing status.
10. Relays to be UL recognized.

C. Products and Manufacturers: Provide one of the following:

1. Automatic Timing and Controls Company, Series 328D.
2. IDEC, Series GE1A.
3. Or equal.

2.13 CURRENT ISOLATOR

A. General: The isolating unit shall be a two wire, loop-powered device. It shall accept a 4 to 20 mA DC input signal and deliver a 4 to 20 mA DC output.

B. Required Features:

1. Repeatability: \pm One percent of span.
2. Ambient Temperature Range: 0°C to 50°C.
3. Ambient Humidity Range: 0 to 95 percent, non-condensing.
4. Accuracy: 0.5 percent.
5. Linearity: \pm 0.1 percent of full scale.
6. Provide one spare isolator.

C. Products and Manufacturers: Provide one of the following:

1. Ronan, X57 Series.
2. Action Instruments, G408 Series.
3. Crompton Instruments, 250 Series.
4. Or equal.

2.14 SIGNAL SPLITTER

A. General: The isolating unit shall be a two wire, loop-powered device. It shall accept a 4 to 20 mA DC input signal and deliver two (2) 4 to 20 mA DC outputs.

B. Required Features:

1. Repeatability: \pm One percent of span.
2. Ambient Temperature Range: 0°C to 50°C.
3. Ambient Humidity Range: 0 to 95 percent, non-condensing.
4. Accuracy: 0.5 percent.
5. Linearity: \pm 0.1 percent of full scale.
6. Provide one spare signal splitter.

C. Products and Manufacturers: Provide one of the following:

1. Phoenix Contact, MCR-C-UI-2UI-DC1.
2. Or equal.

2.15 ELECTRONIC HORN

A. General: The horn shall be of the multi-tone electronic audible type.

B. Required Features:

1. Internal volume control.
2. Field selection of up to 16 different tones.
3. Power: 120 VAC or 24 VDC (provide power supply as required).
4. Operating Temperature: 32 to 120°F.
5. Enclosure Rating: NEMA 4X.

C. Products and Manufacturers: Provide one of the following:

1. Panalarm, Model NTZ.
2. Or equal.

2.16 ALARM BEACON

A. General: Activate flashing light for equipment or alarm activation.

B. Required Features:

1. Provide beacon color as indicated on drawings.
2. Power: 120 VAC or 24 VDC (provide power supply as required).
3. LED type.
4. Operating Temperature: -58°F to 150°F.
5. Enclosure Rating: NEMA 4X.
6. UL Listed.

C. Products and Manufacturers: Provide one of the following:

1. Federal Signal 191XLT
2. Edwards Signaling 125XBR Series
3. Or equal.

2.17 TERMINAL BLOCKS

A. Terminal Blocks: Provide isolated fused snap-on type terminal blocks for termination of field wiring.

- B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type suitable for channel mounting with tubular pressure screw connectors; 300 volt rating.
- D. Provide color-coded (green/yellow) ground bus terminal block, with each connector bonded to enclosure.
- E. Products and Manufacturers: Provide one of the following:
 - 1. Bussmann.
 - 2. Phoenix Contact.
 - 3. Allen Bradley.
 - 4. Square D
 - 5. Or equal.

2.18 SLOTTED WALL WIRING DUCT

- A. General: Provide slotted wall wire duct with snap-on locking covers as required for panel wiring.
- B. Requirements:
 - 1. Material: Rigid PVC
 - 2. UL Flammability Rating: V-0
 - 3. Removable Cover
 - 4. Rounded Edges
 - 5. Size as required.
- C. Products and Manufacturers: Provide one of the following:
 - 1. Panduit Corp.
 - 2. Or equal.

2.19 GLASS TUBE FUSES

- A. General: Provide fast acting, low breaking capacity fuses as required for circuit protection.
- B. Requirements:
 - 1. 5mm x 20mm physical size
 - 2. Glass tube, nickel plated brass endcap construction
 - 3. Designed to UL/CS A 249-14

4. Minimum AC Interrupting Rating:
5. 35 Amps @ 250V
6. 10,000 Amps @ 125V

C. Products and Manufacturers: Provide one of the following:

1. Cooper Bussman, GMA Series.
2. Littlefuse.
3. Or equal.

2.20 CONTROL PANEL HEATER AND SWITCH

A. General: Provide adequately sized, automatically controlled 120 VAC heaters to maintain temperature 10°F above ambient for condensation prevention inside panels.

B. Heater Requirements:

1. Positive Temperature Coefficient heating element.
2. DIN Rail Mountable.
3. Watts: As required.
4. UL Recognized.

C. Temperature Control Switch Requirements:

1. Provide Normally Closed Switch.
2. Provide Normally Open Switch.
3. DIN Rail Mountable.

D. Products and Manufacturers: Provide one of the following:

1. Hoffman.
2. Or equal.

2.21 SPARE PARTS AND TEST EQUIPMENT

A. Contractor shall furnish and deliver the spare parts and test equipment as outlined below, all of which shall be identical and interchangeable with similar parts furnished under this Section.

B. The spare parts shall be packed in containers suitable for long term storage, bearing labels clearly designating the contents and the pieces of equipment for which they are intended.

C. The following shall constitute the minimum spare parts:

1. Five of each type of input-output relay for each 40 or less furnished for this Contract.
2. One replacement power supply for each type and size furnished for this Contract.
3. A one-year supply of all expendable materials.
4. One per ten (two, if fewer than twenty) of each type of panel mounted instrument including lights, pushbuttons and PLC equipment.
5. One dozen of each type and size of fuse used in panels and instruments.

D. The following shall constitute the minimum test and calibration equipment:

1. All special calibration equipment required for system calibration.

E. All spare parts shall have been operated and tested in the factory as part of factory testing prior to shipment of the control system.

F. For analog instruments, the supplier shall submit a separate quotation for a recommended list of spare-parts and test equipment. Each item recommended shall be listed and priced separately. The spare parts quotation shall contain a statement that the prices quoted are firm for a period of one year (with escalators for the next two years) subsequent to the Owner's acceptance of the equipment, and that the supplier understands that the Owner reserves the right to purchase none, any, or all of the parts quoted. The supplier is required to show that a stock of spare-parts and test equipment is obtainable within a 48-hour period.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install each item in accordance with manufacturer's recommendations and in accordance with the Contract Documents.
- B. All items shall be mounted and anchored in compliance with Section 16170, Process Control Panels and Enclosures.

3.02 START-UP. CALIBRATION. TESTING AND TRAINING

- A. Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform and coordinate all required training at times acceptable to Owner.
- B. Contractor shall retain the services of instrument Suppliers as applicable, to provide operation and maintenance training for all specialized control system equipment as specified herein.

- C. Contractor shall be responsible for all costs associated with the training courses and shall provide all required materials, texts and required supplies. All costs, including travel, lodging, meals and incidentals for manufacturer services shall be included in the Contractor's bid.
- D. All training shall be conducted in the normal eight-hour working days until conclusion of the training course.

END OF SECTION

SECTION 16180

EQUIPMENT WIRING

PART 1 GENERAL

1.01 SCOPE

- A. Electrical connections to equipment specified under other sections.

1.02 RELATED SECTIONS

- A. Section 01010 – Summary of Work
- B. Section 16020 – Conduit Systems
- C. Section 16030 – Wire and Cable

1.03 REFERENCES

- A. NEMA WD 1 - General Purpose Wiring Devices
- B. NEMA WD 6 - Wiring Device Configurations
- C. ANSI/NFPA 70 - National Electrical Code

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.05 REGULATORY REQUIREMENTS

- A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.06 COORDINATION

- A. Coordinate work under provisions of Section 01039.

- B. Obtain and review shop drawings, product data, and manufacturer's instructions for equipment furnished under other sections.
- C. Determine connection locations and requirements.
- D. Sequence rough-in of electrical connections to coordinate with installation schedule for equipment.
- E. Sequence electrical connections to coordinate with start-up schedule for equipment.

PART 2 PRODUCTS

2.01 CORDS AND CAPS

- A. Attachment Plug Construction: Conform to NEMA WD 1.
- B. Configuration: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
- C. Cord Construction: ANSI/NFPA 70, Type SO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- D. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify conditions under provisions of Section 01039.
- B. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Make wiring connections using wire and cable with insulation suitable for

temperatures encountered in heat producing equipment.

- D. Provide receptacle outlet where connection with attachment plug is indicated. Provide cord and cap where field-supplied attachment plug is indicated.
- E. Provide suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- F. Install disconnect switches, controllers, control stations, and control devices as indicated.
- G. Modify equipment control wiring with terminal block jumpers as indicated.
- H. Provide interconnecting conduit and wiring between devices and equipment where indicated.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

1.01 SCOPE

- A. Conduit and equipment supports.
- B. Anchors and fasteners.
- C. Concrete housekeeping pads.

1.02 REFERENCES

- A. NECA - National Electrical Contractors Association.
- B. ANSI/NFPA 70 - National Electrical Code.

1.03 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 – Cast-in-place Concrete.

1.04 SUBMITTALS

- A. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.05 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 PRODUCT REQUIREMENTS

- A. Materials and Finishes: Provide adequate corrosion resistance.
- B. Provide materials, sizes, and types of anchors, fasteners and supports to carry the loads of equipment and conduit. Consider weight of wire in conduit

when selecting products. Sizes noted on Drawings shall be considered as the minimum required.

C. Anchors and Fasteners:

1. Concrete block walls: Use expansion anchors.
2. Steel Structural Elements: Use welded fasteners.
3. Concrete Surfaces: Use expansion anchors.

2.02 CHANNEL

A. Manufacturer:

1. Unistrut.
2. Or equal.

B. Materials shall conform to one of the following options unless otherwise required by the Drawings:

1. Galvanized steel.
2. Aluminum
3. Stainless steel

C. Size: 1 5/8" X 1 5/8"

PART 3 EXECUTION

3.01 CONCRETE HOUSEKEEPING PADS

- A. Prior to constructing concrete housekeeping pad(s), review equipment dimensions, conduit requirements, and related data to verify required pad size and layout.
- B. Install required support structure components and conduit penetrations at location of pad. Temporarily cap conduit ends to prevent entrance of foreign materials during construction of housekeeping pad.
- C. Prepare pad subbase area and materials as outlined on the Drawings. Secure support structure components and conduit to maintain position and orientation during installation of subbase materials.
- D. Install concrete housekeeping pad in accordance with the requirements of Section 03300. Protect support structure components and conduit from damage during placement of concrete.
- E. Finish housekeeping pad and cure as outlined in Section 03300.

- F. Restore grade adjacent to pad.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide anchors, fasteners, and supports in accordance with NECA "Standard of Installation".
- C. Do not fasten supports to pipes and conduit except as shown on Drawings.
- D. Obtain permission from Engineer before drilling or cutting structural members.
- E. Fabricate supports from structural steel, galvanized steel, aluminum or stainless steel channel. Rigidly weld members or use stainless steel hex head bolts and hardware to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
- F. Equipment supported from aluminum handrail shall have supports fabricated from aluminum or stainless steel channel. Use stainless steel hex head bolts, washers and nuts. Galvanized channel and bolts will not be permitted.
- G. Install surface-mounted cabinets and panel boards with minimum of four anchors.
- H. In wet and damp locations use stainless steel or aluminum channel supports with stainless steel fasteners.
- I. In wet and damp locations use stainless steel or aluminum channel supports to stand cabinets and panel boards one inch (25 mm) off wall.
- J. Spray coat cut end of galvanized steel channel or rigid steel conduit with spray cold galvanizing.
- K. Galvanized pipe used as equipment supports are to have the open ends capped with galvanized end caps.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE

- A. Nameplates and labels.
- B. Wire and cable markers.
- C. Conduit markers.

1.02 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01300 and Section 16010.
- B. Product Data: Provide catalog data for nameplates, labels, and markers.

1.04 REGULATORY REQUIREMENTS

- A. Conform to requirements of ANSI/NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc.

PART 2 PRODUCTS

2.01 NAMEPLATES AND LABELS

- A. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
- B. Locations:
 - 1. Each electrical distribution and control equipment enclosure.
 - 2. Each junction box.
- C. Letter Size:
 - 1. Use 1/4-inch letters for identifying individual equipment and loads.

2. Use 1/4-inch letters for identifying grouped equipment and loads.

2.02 WIRE MARKERS

A. Manufacturers:

1. T & B Shrink-Kon HVM wire markers.
2. Panduit - Pan Code HSDL.
3. Brady.
4. Or equal.

B. Description: Tubing type wire markers.

C. Locations: Each conductor at panelboard gutters, outlet and junction boxes, terminal strip and each load connection.

D. Legend:

1. Power and Lighting Circuits: Branch circuit or feeder number indicated on Drawings.
2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams on drawings or on shop drawings.

2.03 UNDERGROUND WARNING TAPE

A. Description: 6-inch wide bright colored, metal-backed, polyethylene plastic tape. Continuous imprinting, "CAUTION BURIED ELECTRIC LINE BELOW", or equivalent.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.02 APPLICATION

A. Install nameplate parallel to equipment lines.

B. Secure nameplate to equipment front using screws, rivets, or adhesive.

C. Identify underground conduits using underground warning tape. Install one tape per trench at 12 inches below finished grade.

END OF SECTION

SECTION 16230

STANDBY GENERATOR SET

PART 1 GENERAL

1.01 SCOPE

- A. It is the intent of this specification to secure an engine-driven generator set that has been prototype tested, factory built, production-tested, and site-tested together with all accessories necessary for a complete installation as shown on the plans and drawings and specified herein.
- B. Any and all exceptions to the published specifications shall be subject to the approval of the engineer.
- C. The power system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system. The entire system shall be installed as shown on the plans, drawings, and specifications herein.
- D. The equipment shall be produced by a manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available twenty-four hours a day throughout the year.
- E. The equipment shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production and service of its complete product line.

1.02 GENERAL REQUIREMENTS

- A. It is the intent of this specification to secure a generator set system that has been tested during design verification, in production, and at the final job site. The generator set will be a commercial design and will be complete with all of the necessary accessories for complete installation as shown on the plans, drawings, and specifications herein. The equipment supplied shall meet the requirements of the National Electrical Code and applicable local codes and regulations.
- B. All equipment shall be new and of current production by a national firm that manufactures the generator sets and controls, transfer switches, and switchgear, and assembles the generator sets as a complete and coordinated system. There will be one-source responsibility for warranty, parts, and service through a local representative with factory-trained servicemen.

1.03 SUBMITTALS

- A. Provide submittals for equipment in accordance with Section 01300.
- B. The submittal shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied; schematic wiring diagrams, dimension drawings, and interconnection diagrams identifying by terminal number each required interconnection between the generator set, the transfer switch, and the remote annunciator panel if it is included elsewhere in these specifications.

1.04 CODES, REGULATIONS, AND STANDARDS

- A. The generator set shall be listed to UL 2200 or submitted to an independent third party certification process to verify compliance as installed.
- B. The generator set shall conform to the requirements of the following codes and standards:
 - 1. CSA C22.2, No. 14-M91 Industrial Control Equipment.
 - 2. EN50082-2, Electromagnetic Compatibility-Generic Immunity Requirements, Part 2: Industrial.
 - 3. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
 - 4. IEC8528 part 4, Control Systems for Generator Sets.
 - 5. IEC Std 61000-2 and 61000-3 for susceptibility, 61000-6 radiated and conducted electromagnetic emissions.
 - 6. IEEE446 Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - 7. NFPA 70, National Electrical Code, Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
 - 8. NFPA 99, Essential Electrical Systems for Health Care Facilities.
 - 9. NFPA 110, Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype tests required by this standard shall have been performed on a complete and functional unit. Component level type tests will not substitute for this requirement.

1.05 WARRANTY AND MAINTENANCE

- A. The generator set shall include a standard one year warranty to guarantee against defective material and workmanship in accordance with the manufacturer's published warranty from date of substantial completion. Optional warranties shall be available upon request.
- B. The generator set manufacturer and its distributor shall maintain a 24-hour parts and service organization. This organization shall regularly engage in

maintenance contract programs to perform preventive maintenance and service on equipment similar to that specified. A service agreement shall be available and shall include system operation under simulated operating conditions; adjustment to the generator set, transfer switch, and switchgear controls as required, and certification in the owner's maintenance log of repairs made and function tests performed on all systems.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. The generator set shall be a Kohler model 350REOZJ with a 4M4019 alternator, or equal.
- B. The generator set shall provide 437.50 kVA and 350.00 kW when operating at 277/480 volts, 60 Hz, 0.80 power factor. The generator set shall be capable of a 130°C Standby rating while operating in an ambient condition of less than or equal to 77 °F and a maximum elevation of 500 ft above sea level. The standby rating shall be available for the duration of the outage.

2.02 ENGINE

- A. The minimum 13.5 liter displacement engine shall deliver a minimum of 538 HP at a governed engine speed of 1800 rpm, and shall be equipped with the following:
 - 1. Electronic isochronous governor capable of 0.25% steady-state frequency regulation.
 - 2. 24-volt positive-engagement solenoid shift-starting motor.
 - 3. 60-ampere automatic battery charging alternator with a solid-state voltage regulation.
 - 4. Positive displacement, full-pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
 - 5. Dry-type replaceable air cleaner elements for normal applications.
 - 6. Engine-driven or electric fuel-transfer pump including fuel filter and electric solenoid fuel shutoff valve capable of lifting fuel.
 - 7. The engine shall have a minimum of 6 cylinders and be liquid-cooled.
- B. The turbocharged, intercooled engine shall be fueled by diesel.
- C. The engine shall be EPA certified from the factory.
- D. The generator must accept rated load in one-step.

2.03 COOLING SYSTEM

- A. The engine shall be liquid-cooled by a closed loop, unit mounted radiator rated to operate the generator set at full load at an ambient temperature of 50 degrees C (122 degrees F). The radiator fan and other rotating engine parts shall be guarded against accidental contact.

2.04 STANDARD AIR CLEANER

- A. The air cleaner shall provide engine air filtration which meets the engine manufacturer's specifications under typical operating conditions.

2.05 BATTERY

- A. Each genset requires a BCI group 31 batteries which must meet the engine manufactures' specifications for the ambient conditions specified in Part 1 Project Conditions and shall comply with the NFPA requirements for engine cranking cycles. Each battery shall be rated according to SAE Standards J-537 with a minimum cold cranking amp of 950 amps and a minimum reserve capacity of 185 Minutes at 80F. The battery plates shall be constructed of a Calcium-Lead alloy to provide long waterless operation and extended battery life. The battery elements must be anchor-locked with full-frame grids and tight-packed commercial plates to resist the effects of vibration. The battery must contain a handle to aid in lifting and the case must be constructed of polypropylene to resist breakage and extend service life. Removable cell covers shall be provided to allow for checking of electrolyte specific gravity.
- B. Battery rack and battery cables capable of holding the manufacturer's recommended batteries shall be supplied.

2.06 HOUSING

- A. Level 2 Sound Attenuated Enclosure
 - 1. The generator set shall be supplied with a Level 2 Sound Attenuated Enclosure, providing a sound level of 74 dB(A) while the generator is operating at 100% load at 7 meters (23 feet) using acoustic insulation and acoustic-lined inlet hoods, and constructed from high strength, low alloy 14 gauge galvanized steel. The acoustic insulation used shall meet UL 94 HF1 flammability classification. The enclosure shall be manufactured from bolted panels to facilitate service, future modifications, or field replacement. The enclosure shall use external vertical air inlet and outlet hoods with 90 degree angles to discharge air up and reduce noise. The enclosure shall have an integral rodent

- guard and skid end caps and shall have bracing to meet 241 kph (150 mph) wind loading.
2. The enclosure components and skid shall be cleaned with a two-stage alkaline cleaning process to remove grease, grit, and grime from parts. Components shall then be subjected to a Zirconium-based conversion coating process to prepare the metal for electrocoat (e-coat) adhesion. All enclosure parts shall receive an 100% epoxy primer electrocoat (e-coat) with high-edge protection. Following the e-coat process, the parts shall be finish coated with powder baked paint for superior finish, durability, and appearance with an industrial finish that provides heavy duty durability in harsh conditions, and is fade-, scratch- and corrosion-resistant.
 3. The enclosure must surpass a 3,000 hour salt spray corrosion test per ASTM B-1117.
 4. Enclosures will be finished in the manufacturer's standard color.
 5. The enclosures shall allow the generator set to operate at full load in an ambient temperature of 50°C with no additional derating of the electrical output of the generator set.
 6. Enclosures shall be equipped with sufficient side and end doors to allow access for operation, inspection, and service of the unit and all options. Minimum requirements are two doors per side. When the generator set controller faces the rear of the generator set, an additional rear facing door is required. Access to the controller and main line circuit breaker shall meet the requirements of the National Electric Code.
 7. Doors shall be fitted with hinges, hardware, and the doors shall be removable.
 8. Doors shall be equipped with lockable latches. Locks shall be keyed alike. Door locks shall be recessed to minimize potential of damage to door/enclosure.
 9. A duct between the radiator and air outlet shall be provided to prevent re-circulation of hot air.
 10. The complete exhaust system shall be internal to the enclosure.
 11. The critical silencer shall be fitted with a tailpipe and rain cap.

2.07 FUEL OIL STORAGE

A. Double Wall Secondary Containment Sub-base Fuel Tank

1. The generator set shall be supplied with a sub-base fuel tank of sufficient capacity to hold 774 gallons of diesel fuel.
2. The sub-base fuel system shall be listed under UL 142, subsection entitled Special Purpose Tanks EFVT category, and will bear their mark of UL Approval according to their particular classification.
3. The above ground steel secondary containment rectangular tank for use as a sub base for diesel generators is manufactured and intended

to be installed in accordance with the Flammable and Combustible Liquids Code—NFPA 30, the Standard for Installation and Use of Stationary Combustible Engine and Gas Turbines—NFPA 37, and Emergency and Standby Power Systems—NFPA 110.

4. The primary tank shall be rectangular in shape and constructed in clam shell fashion to ensure maximum structural integrity and allow the use of a full throat fillet weld.
5. Steel Channel Support System. Reinforced steel box channel for generator support, with a load rating of 5,000 lbs. per generator mounting hole location. Full height gussets at either end of channel and at generator mounting holes shall be utilized.
6. Exterior Finish. The sub-base tank exterior finish shall be a polyurea-textured rubberized coating.
7. Normal venting shall be sized in accordance with the American Petroleum Institute Standard No 2000, Venting Atmospheric and Low Pressure Storage Tanks not less than 1-1/4" (3 cm.) nominal inside diameter.
8. The emergency vent opening shall be sized to accommodate the total capacity of both normal and emergency venting and shall be not less than that derived from NFPA 30, table 2-8, and based on the wetted surface area of the tank. The wetted area of the tank shall be calculated on the basis of 100 percent of the primary tank. The vent is to be spring-pressure operated: opening pressure is 0.5/psig and full opening pressure is 2.5 psig. The emergency relief vent is to be sized to accommodate the total venting capacity of both normal and emergency vents.
9. There shall be a 2" NPT opening within the primary tank and lockable manual fill cap.
10. A direct reading, UL listed, magnetic fuel level gauge with a hermetically sealed, vacuum tested dial, to eliminate fogging, shall be provided.
11. A float switch for remote or local annunciation of a (50% standard) low fuel level condition shall be supplied.
12. Fuel fill option – The fuel fill is equipped with a 5 gallon above ground fill/spill container that contains fuel over spills that may occur during fill-ups and the normal vent will be extended to 12' above the grade.
13. Five (5) Gallon Fill/Spill Containment- Aboveground fill/spill container, contains fuel overfill spills that may occur during fill-up.

2.08 ALTERNATOR

- A. The alternator shall be salient-pole, brushless, 2/3-pitch, with 4 bus bar provision for external connections, self-ventilated, with drip-proof construction and amortisseur rotor windings, and skewed for smooth voltage waveform. The ratings shall meet the NEMA standard (MG1-32.40) temperature rise limits. The insulation shall be class H per UL1446

and the varnish shall be a vacuum pressure impregnated, fungus resistant epoxy. Temperature rise of the rotor and stator shall be limited to 130°C Standby. The PMG based excitation system shall be of brushless construction controlled by a digital, three phase sensing, solid- state, voltage regulator. The AVR shall be capable of proper operation under severe nonlinear loads and provide individual adjustments for voltage range, stability and volts-per-hertz operations. The AVR shall be protected from the environment by conformal coating. The waveform harmonic distortion shall not exceed 5% total RMS measured line-to-line at full rated load. The TIF factor shall not exceed 50.

- B. The alternator shall have a maintenance-free bearing, designed for 40000 hour B10 life. The alternator shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.
- C. The generator shall be inherently capable of sustaining at least 300% of rated current for at least 10 seconds under a 3-phase symmetrical short circuit without the addition of separate current-support devices.
- D. Motor starting performance and voltage dip determinations shall be based on the complete generator set. The generator set shall be capable of supplying 1,325.00 LRKVA for starting motor loads with a maximum instantaneous voltage dip of 35%, as measured by a digital RMS transient recorder in accordance with IEEE Standard 115. Motor starting performance and voltage dip determination that does not account for all components affecting total voltage dip, i.e., engine, alternator, voltage regulator, and governor will not be acceptable. As such, the generator set shall be prototype tested to optimize and determine performance as a generator set system.

2.09 VIBRATION ISOLATION

- A. Vibration isolators shall be provided between the engine-alternator and heavy-duty steel base.

2.10 CONTROLLER

A. Generator Set Controller

- 1. The generator set controller shall be a microprocessor based control system that will provide automatic starting, system monitoring and protection. The controller system shall also provide local monitoring and remote monitoring. The control system shall be capable of PC based updating of all necessary parameters, firmware and software.

2. The controller shall be mounted on the generator set and shall have integral vibration isolation. The controller shall be prototype and reliability tested to ensure operation in the conditions encountered.
- B. Controller Buttons, Display and Components – The generator set controller shall include the following features and functions:
1. Push button Master Control buttons. The buttons shall be tactile-feel membrane with an indicator light to initiate the following functions:
 - a. Run Mode – When in the run mode the generator set shall start as directed by the operator.
 - b. Off/Reset Mode – When in the off/reset mode the generator set shall stop, the reset shall reset all faults, allowing for the restarting of the generator set after a shutdown.
 - c. Auto Mode – When in Auto mode the generator set shall be ready to accept a signal from a remote device.
 2. Emergency Stop Switch. The remote stop switch shall be red in color with a "mushroom" type head. Depressing the stop button will immediately stop the generator set and lockout the generator set for any automatic remote starting.
 3. Push Button/Rotary Selector dial. This dial shall be used for selection of all Menus and sub-menus. Rotating the dial moves you through the menus, pushing the dial selects the menu and function/features in that menu. Pushing the button selects the feature/function and sub-menus.
 4. Digital Display. The digital display shall be alphanumeric, with 2 lines of data and approximately 24 characters. The display shall have back lighting for ease of operator use in high and low light conditions. The display shall display status of all faults and warnings. The display shall also display any engine faults. While the generator set is running the display shall scroll all important information across the screen for ease of operator use. The scroll can be stopped by pushing the rotary dial. The display shall fall asleep when the generator set is not running and will wake-up when the generator set starts or the rotary dial is depressed.
 5. Fault Light. The controller shall have an annunciator fault light that glows red for faults and yellow for warnings. These faults and warnings shall be displayed in the digital display. The fault light will also glow yellow when not in AUTO.
 6. Alarm Horn. The controller shall provide an alarm horn that sounds when any faults or warnings are present. The horn shall also sound when the controller is not in the AUTO mode.
 7. Alarm Silence/Lamp Test Button. When this button is depressed it shall test all controller lamps. This button will also silence the alarm horn when the unit is not AUTO.
 8. USB Connection. The controller shall have a USB connection on the face of the controller. This connection shall allow for updating of all

software and firmware. This port shall also allow for all servicing of generator set parameters, fault diagnostics and viewing of all controller information via use of a laptop computer.

9. Dedicated user inputs. The controller shall have dedicated inputs for remote emergency stop switch, remote 2 wire start for transfer switch and auxiliary shutdown.
10. The controller shall have auto resettable circuit protection integral on the circuit board.

C. System Controller Monitoring and Status Features and Functions – The generator controller shall display and monitor the following engine and alternator functions and allow adjustments of certain parameters at the controller:

1. Overview Menu:
 - a. Active shutdowns and warnings shall be displayed if present and without the need of operator interface
 - b. Engine runtime with total hours
 - c. Average line to line voltage
 - d. Coolant temperature
 - e. Fuel level or pressure
 - f. Oil pressure
 - g. Battery voltage
 - h. Software version
 - i. Frequency
 - j. Average current
2. Engine metering menu:
 - a. Engine speed
 - b. Oil pressure
 - c. Coolant temperature
 - d. Battery voltage
3. Generator metering menu:
 - a. Total power in VA
 - b. Total power in W
 - c. Rated power % used
 - d. Voltage L-L and L-N for all phases
 - e. Current L1, L2, L3
 - f. Frequency
4. Generator set information:
 - a. Generator set model number
 - b. Generator set serial number
 - c. Controller set number
5. Generator set run time:
 - a. Engine run time total hours
 - b. Engine loaded total hours
 - c. Number of engine starts

- d. Total energy in kW
- 6. Generator set system:
 - a. System voltage
 - b. System frequency 50/60Hz
 - c. System phase, single/three phase
 - d. Power rating kW
 - e. Amperage rating
 - f. Power type standby/prime
 - g. Measurement units, metric/English units adjustable
 - h. Alarm silence, always or auto only
- 7. Generator set calibration, the following are adjustable at the controller:
 - a. Voltage L-L and L-N all phases
 - b. Current L1, L2, L3
 - c. Reset all calibrations
- 8. Voltage regulation, +/-0.5% regulation, the following is adjustable at the controller:
 - a. Voltage Adjustable +/- 10%
- 9. Digital and Analog Inputs and outputs:
 - a. Displays settings and status
- 10. Event Log
 - a. Stores event history, up to 1000 events

D. Controller Engine control features and functions:

- 1. Automatic restart – the controller has automatic restart feature which initiates the start routine and re-crank after a failed start attempt.
- 2. Cyclic cranking – the controller shall have programmable cyclic cranking.
- 3. Engine starting aid – the controller shall have the capability of providing control for an optional engine starting aid.
- 4. The control system shall include time delays for engine start and cool down.
- 5. The control system shall interface with the engine ECM and display engine fault codes and warnings. The ECM shall also include sender failure monitoring to help distinguish between failed senders and actual failure conditions.
- 6. The controller shall monitor and display engine governor functions which include steady state and transient frequency monitoring.

E. Controller Alternator control features and functions

- 1. Integrated hybrid voltage regulator. The system shall have integral microprocessor based voltage regulator system that provides +/- 5% voltage regulation, no-load to full load with three phase sensing. The system is prototype tested and control variation of voltage to

frequency. The voltage regulator shall be adjustable at the controller with maximum +/- 10% adjustable of nominal voltage.

2. AC output voltage regulator adjustment. The system shall allow for adjustment of the integral voltage regulator with maximum of +/- 10% adjustment of the system voltage.
3. Alternator thermal overload protection. The system shall have integral alternator overload and short circuit protection matched to each alternator for the particular voltage and phase configuration.
4. Power metering. The controller digitally displays power metering of kW and kVA.

F. Other control features and functions

1. Event logging – The controller keeps a record of up to 1000 events, for warning and shutdown faults. This fault information becomes a stored record of systems events and can be reset.
2. Historical data logging – The controller total number of generator set successful start shall be recorded and displayed.
3. Programmable access – The control system shall include a USB port that gives service technicians the ability to provide software and firmware upgrades. The system shall also be capable of allowing setting of all critical parameters using the service software and a laptop computer. All parameters and settings should be capable to being stored on a laptop for future upgrades or printing for analysis.

G. Generator Set Warning, Shutdown Alarm and Status – The generator set shall have alarms and status indication lamps that show non-automatic status and warning and shutdown conditions. The controller shall indicate with a warning lamp and or alarm and on the digital display screen any shutdown, warning or engine fault condition that exists in the generator set system. The following alarms and shutdowns shall exist as a minimum:

1. Engine functions
 - a. Critical high fuel level (alarm)
 - b. ECM communication loss (shutdown)
 - c. ECM diagnostics (alarm & shutdown)
 - d. Engine overspeed (shutdown)
 - e. Engine start aid active
 - f. Engine under speed (shutdown)
 - g. Fuel tank leak (alarm & shutdown)
 - h. High DC battery voltage (alarm)
 - i. High coolant temperature (alarm & shutdown)
 - j. High fuel level (alarm)
 - k. Low DC battery voltage (alarm)
 - l. Low coolant level (shutdown)
 - m. Low coolant temperature (alarm)

- n. Low cranking voltage (alarm)
- o. Low engine oil level (alarm & shutdown)
- p. Low fuel level (alarm & shutdown)
- q. Low fuel pressure (alarm)
- r. Low oil pressure (alarm & shutdown)
- s. No coolant temperature signal (shutdown)
- t. No oil pressure signal (shutdown)
- u. Overcrank (shutdown)
- v. Speed sensor fault (alarm)
- 2. Generator functions
 - a. AC sensing loss over & under current (alarm & shutdown)
 - b. Alternator protection (shutdown)
 - c. Ground fault input (alarm)
 - d. kW overload (shutdown)
 - e. Locked rotor (shutdown)
 - f. Over-frequency (shutdown)
 - g. Over AC voltage (shutdown)
 - h. Under-frequency (shutdown)
 - i. Under AC voltage (shutdown)
 - j. Emergency stop (shutdown)
- 3. Other General functions
 - a. Battery charger fault (alarm)
 - b. Common fault (shutdown)
 - c. Common warning (alarm)
 - d. Master switch not in auto (alarm)
 - e. Generator running
 - f. Input / Output fault (alarm)
- 4. The generator set controller shall also be capable of meeting all necessary NFPA 110 level 1 requirements which include several of the above along with; EPS supplying load, Master switch not in auto and contacts for local and remote common alarm.

2.11 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. The generator shall be provided with a factory installed, 100% rated line circuit breaker rated at 600.00 amperes that is UL489 listed. Line circuit breakers shall be sized for the rated ampacity of the loads served by the breaker per the NEC.
- B. The circuit breaker(s) shall incorporate an electronic trip device with the following characteristics:
 - C. Adjustable long time delay
 - D. Adjustable short time delay
 - E. Instantaneous
- F. Load side lugs shall be provided from the factory. The line circuit breaker shall include auxiliary contacts, shunt trip, undervoltage trip, alarm switch, and overcurrent switch functionality. Load side breaker connections made at the factory shall be separated from field connections.

- G. The shunt trip device shall be connected to trip the generator breaker when the generator-set is shut down by other protective devices.
- H. When GFI is required per the NEC, additional neutrals shall be factory installed, and the alarm indication shall be integrated with the generator-set alarms.
- I. Barriers to provide segregation of wiring from an emergency source to emergency loads from all other wiring and equipment, if required by the NEC, shall be provided.

2.12 ACCESSORIES

- A. Battery Charger – The generator set shall be supplied with a 10-ampere automatic float/equalize battery charger capable of charging both lead-acid and ni-cad type batteries, with the following features:
 - 1. Automatic 3-stage float to equalization charge
 - 2. Voltage regulation of 1% from no to full load over 10% AC input line voltage variations
 - 3. Battery charging current Ammeter and battery voltage voltmeter with 5% full-scale accuracy
 - 4. LED lamp for power ON indication
 - 5. Current limited during engine cranking, short circuit, and reverse polarity conditions
 - 6. Temperature compensated for ambient temperatures for -40°C to 60°C
 - 7. Alarm circuit board featuring alarm contacts for low battery voltage, high battery voltage, and battery charger malfunction.
 - 8. UL 1012 Listed
- B. Battery Rack and Cables – Battery rack and battery cables capable of holding the manufacturer's recommended batteries shall be supplied.
- C. Air Restriction Indicator – The air cleaner restriction indicator shall indicate the need for maintenance of the air cleaners.
- D. Emergency Stop Switch - The generator shall be furnished with an externally mounted, recessed, emergency stop switch (break glass, pushbutton style) protected from accidental operation.
- E. Failure Relay - The generator set shall be supplied with a common failure relay to provide means of signaling fault and/or shutdown conditions.
 - 1. The common failure relay shall remotely signal auxiliary faults, emergency stop, high engine temperature, low oil pressure, overcrank, and over speed via one single-pole, double-throw relay with 10 amps at 120 VAC contacts.

2. The relay contacts shall be gold flashed to allow use of low current draw devices (100ma @ 28VDC min.).
 3. Once energized the relay shall remain latched until the system is reset by the main controller switch.
- F. Block Heater - The block heater shall be thermostatically controlled, 2,500 watt, with isolating valves, to maintain manufacturers recommended engine coolant temperature to meet the start-up requirements of NFPA 99 and NFPA 110, Level 1.
- G. Fuel Lines - Supply flexible fuel lines to provide a flexible connection between the engine fuel fittings and the fuel supply tank piping and for the fuel return lines from the injector pump per engine manufacturer's recommendations. Flex line shall have a protective steel wire braid to protect the hose from abrasion.
- H. Run Relay - The generator set shall be provided with a run relay which shall provide a three-pole, double-throw relay with 10-amp/ 250 VAC contacts to indicate that the generator is running. The run relay dry contacts can be used for energizing or de-energizing customer devices while the generator is running (e.g. louvers, indicator lamps, etc.).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with the details shown on the Drawings, approved Shop Drawings, and the recommendations of the Manufacturer.
- B. Furnish and install all necessary supports and anchor bolts.
- C. Adjust all equipment and leave in proper working condition.
- D. When separate silencer mounting is indicated, furnish silencer and flex connector for installation by the Mechanical Contractor.
- E. A competent and experienced Manufacturer's Representative shall check the installation of the equipment, supervise its initial operation, and instruct operating personnel in its operation and maintenance.

3.02 TESTING

- A. To ensure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and/or local representative shall be responsible for three separate tests: design prototype tests, final production tests, and site tests.

- B. Design Prototype Tests. Components of the emergency system, such as the engine/generator set, transfer switch, and accessories, shall not be subjected to prototype tests because the tests are potentially damaging. Rather, similar design prototypes and preproduction models shall be subject to the following tests:
1. Maximum power (kW).
 2. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
 3. Alternator temperature rise by embedded thermocouple and/or by resistance method per NEMA MG1-32.6.
 4. Governor speed regulation under steady-state and transient conditions.
 5. Voltage regulation and generator transient response.
 6. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
 7. Three-phase short circuit tests.
 8. Alternator cooling air flow.
 9. Torsional analysis to verify that the generator set is free of harmful torsional stresses.
 10. Endurance testing.
- C. Final Production Tests. Each generator set shall be tested under varying loads with guards and exhaust system in place. Tests shall include:
1. Single-step load pickup
 2. Safety shutdown device testing
 3. Rated Power @ 0.8 PF
 4. Maximum power
 5. Upon request, a witness test, or a certified test record sent prior to shipment.
- D. Site Tests. The manufacturer's distribution representative shall perform an installation check, startup, and building load test. The engineer, regular operators, and the maintenance staff shall be notified of the time and date of the site test. The tests shall include:
1. Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations, under the environmental conditions present and expected.
 2. Accessories that normally function while the set is standing by shall be checked prior to cranking the engine. These shall include: block heaters, battery chargers, alternator strip heaters, remote annunciators, etc.
 3. Generator set startup under test mode to check for exhaust leaks, path of exhaust gases outside the building, cooling air flow, movement during starting and stopping, vibration during operation, normal and emergency line-to-line voltage and frequency, and phase rotation.

4. Automatic start by means of a simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. Prior to this test, all transfer switch timers shall be adjusted for proper system coordination. Engine coolant temperature, oil pressure, and battery charge level along with generator set voltage, amperes, and frequency shall be monitored throughout the test.

END OF SECTION

SECTION 16413

AUTOMATIC TRANSFER SWITCH

PART 1 GENERAL

1.01 SCOPE

- A. Furnish and install an automatic transfer switch system.

1.02 CODES AND STANDARDS

- A. The automatic transfer switches and controls shall conform to the requirements of:
 - 1. UL 1008 - Standard for Transfer Switch Equipment
 - 2. IEC 947-6-1 Low-voltage Switchgear and Control gear; Multifunction equipment; Automatic Transfer Switching Equipment
 - 3. NFPA 70 - National Electrical Code
 - 4. NFPA 99 - Essential Electrical Systems for Health Care Facilities
 - 5. NFPA 110 - Emergency and Standby Power Systems
 - 6. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 7. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches
 - 8. UL 508 Industrial Control Equipment
 - 9. CSA C22.2 No. 178 certification

1.03 SUBMITTALS

- A. Submit information and documentation under the provisions of Section 01300 and Section 16010 and provide the following:
 - 1. Product Data on specified product;
 - 2. Shop Drawings on specified product;
 - 3. Trip curves for each specified product.

1.04 QUALIFICATIONS

- A. The automatic transfer switch shall be produced by a manufacturer who is ISO 9001 certified for the design, development, production and service of its complete product line.
- B. A manufacturer who has produced this type of equipment for a period of at least 10 years and who maintains a service organization available

twenty-four hours a day throughout the year shall produce the automatic transfer switch.

1.05 WARRANTY

- A. The automatic transfer switch shall be protected by a manufacturer's warranty as follows:
 - 1. The automatic transfer switch shall be warranted against defects in workmanship for a period of two years.
 - 2. The automatic transfer switch shall be warranted against defects in materials for a period of five years.
 - 3. The main contacts of the automatic transfer switch shall be warranted against defects for a period of two years.
- B. The warranty period(s) shall start at the date of substantial completion.

PART 2 PRODUCTS

2.01 EQUIPMENT

- A. Furnish and install an automatic transfer switches system(s) with 4-Pole / 4-Wire, Switched Neutral, 800 Amps, 480V, 60Hz.
- B. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

2.02 ACCEPTABLE MANUFACTURERS

- A. Automatic transfer switches shall be Kohler Any Breaker Rated - Programmed Transition (KCP)/KCP-AMVF-0800S, or equal.

2.03 MECHANICALLY HELD TRANSFER SWITCH

- A. The transfer switch shall be electrically operated and mechanically held with double throw construction, and operated by a momentarily energized solenoid-driven mechanism. Main operators shall include overcurrent disconnect devices; linear motors or gears shall not be acceptable.
- B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and

contact temperature rise is minimized for maximum reliability and operating life.

- D. All main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
- G. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.04 ENCLOSURE

- A. The ATS shall be furnished in a NEMA 4 X enclosure with heater.
- B. All standard door mounted switches and long life super bright type indicating LEDs described herein shall be integrated into a flush-mounted, interface membrane or equivalent in the enclosure door for easy viewing & replacement. The panel shall be capable of having manual locking feature to allow the user to lockout all membrane mounted control switches to prevent unauthorized tampering. This cover shall be mounted with hinges and have a latch that may be padlocked. The membrane panel shall be suitable for mounting by others when furnished on open type units.

2.05 CONTROLLER DISPLAY AND KEYPAD

- A. A four line, 20 character LCD display and dynamic 4 button keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the communications interface port. The following parameters shall only be adjustable via a password protected programming on the controller (dip switches shall not be acceptable):
 - 1. Nominal line voltage and frequency

2. Single or three phase sensing
3. Operating parameter protection
4. Transfer operating mode configuration (Open transition, Closed transition, or Delayed transition)

- B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.06 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage (all phases) and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

Parameter	Dropout/Trip	Pickup/Reset
Under voltage	75 to 98%	85 to 100%
Over voltage	105 to 135%	95 to 100% of trip
Under frequency	85 to 99%	95 to 99%
Over frequency	105 to 120%	101 to 105%
Voltage unbalance	5 to 20%	3% to 18%

- B. Repetitive accuracy of all settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 70°C .
- C. An adjustable dropout time for transient voltage and frequency excursions shall be provided. The time delays shall be 0.1 to 9.9 seconds for voltage and 0.1 to 15 seconds for frequency.
- D. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via the communications interface port.
- E. The controller shall be capable of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or BAC). Unacceptable phase rotation shall be indicated on the LCD; the service required LED and the annunciation through communication protocol and dry contacts. In addition, the phase rotation sensing shall be capable of being defeated, if required.
- F. The controller shall be capable of detecting a single phasing condition of a source, even though a voltage may be regenerated by the load. This condition shall be considered a failed source.

- G. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases (phase to phase and phase to neutral), frequency, and phase rotation.

2.07 TIME DELAYS

- A. An adjustable time delay of 0 to 10 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 12 or 24 VDC power supply.
- B. A time delay shall be provided on transfer to the emergency source, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. A time delay shall be provided on re-transfer to normal. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.
- E. A time delay activated output signal shall also be provided to drive external relay(s) for selective load disconnect control. The controller shall be capable of controlling a maximum of 9 individual output time delays to step loads on after a transfer occurs. Each output may be individually programmed for their own time delay of up to 60 minutes. Each sequence shall be independently programmed for transferring from normal to emergency and transferring from emergency to normal.
- F. The controller shall also include the following built-in time delays for the following operations:
 - 1. 0 to 60 minute time delay on failure to acquire the acceptable electrical parameters from the emergency source
 - 2. 0 to 60 minute time delay for a failure to synchronize on an in-phase operation.
 - 3. 60 minute time delay for the load disconnect position for delayed transition operation.
- G. All time delays shall be adjustable in 1 second increments.
- H. All time delays shall be adjustable by using the display and keypad or with a remote device connected to the communications interface port through a security-password system.

- I. All time delays shall be adjustable by using the display and keypad or with a remote device connected to the communications interface port through a security-password system.
- J. Each time delay shall be identified and a dynamic countdown shall be shown on the display.

2.08 ADDITIONAL FEATURES

- A. The controller shall have 3 levels of security. Level 1 shall allow monitoring of settings and parameters only. The Level 1 shall be capable of restricted with the use of a lockable cover. Level 2 shall allow test functions to be performed and Level 3 shall allow setting of all parameters.
- B. Membrane-type switches shall be provided for the test functions and be maintained until the end test function is activated. The test function shall be allowed through password security. It shall be possible to defeat the password requirement by way of a circuit board mounted dip switch setting. The test function shall be load, no load or auto test. The auto test function shall request an elapsed time for test. At the completion of this time delay the test shall be automatically ended and a retransfer sequence shall commence. All loaded tests shall be immediately ended and retransfer shall occur if the emergency source fails and the normal source is acceptable.
- C. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low-voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output, and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- D. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of two contacts, closed when the ATS is connected to the normal source and two contacts closed, when the ATS is connected to the emergency source.
- E. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- F. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal (green) and emergency sources (red), as determined by the voltage, frequency and phase rotation sensing trip and reset settings for each source.

- G. A membrane switch shall be provided on the membrane panel to test all indicating lights and display when pressed.
- H. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.
- I. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which closes to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or the communications interface port. A "not-in-auto" LED shall indicate anytime the controller is inhibiting transfer from occurring.
- J. The programmed transition feature shall control the transfer so that mechanism is placed in a load disconnect position for an adjustable period of time, giving motor and transformer loads have an opportunity to decay to acceptable levels. The programmed transition feature shall be specifically designed for and be the product of the ATS manufacturer. The programmed transition setting shall be capable of being enabled or disabled from the user interface. The controller shall include a built-in time delay for programmed transition operation. This time shall be adjustable from the user interface. The default value shall be 1 second and shall be adjustable from 0 to 60 minutes.
- K. Engine Exerciser – The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to 21 different exercise routines based on a calendar mode. For each routine, the user shall be able to:
 - 1. Enable or disable the routine.
 - 2. Enable or disable transfer of the load during routine.
 - 3. Set the start time,
 - a. time of day
 - b. day of week
 - c. week of month (1st, 2nd, 3rd, 4th, alternate or every)
 - 4. Set the duration of the run.
 - 5. At the end of the specified loaded exercise duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. All loaded exercises shall be immediately ended and retransfer shall occur if the standby source fails. The next exercise period shall be displayed on the main screen with the type of exercise, time and date. The type of exercise and the time remaining shall be displayed when the exercise is active. It shall be possible of ending the exercise event with a single button push.

- L. Date and time – The date shall automatically adjust for leap year and the time shall have the capability of automatically adjusting for daylight saving and standard times.
- M. System Status – The controller shall have a default display the following on:
1. System status
 2. Date, time and type of the next exercise event
 3. Average voltage of the preferred and standby sources
 4. Scrolling through the displays shall indicate the following:
 - a. Line to line and line to neutral voltages for both sources
 - b. Frequency of each source
 - c. Load current for each phase
 - d. Single or three phase operation
 - e. Type of transition
 - f. Preferred source
 - g. Commit or no commit modes of operation
 - h. Source/source mode (Utility/Gen; Gen/Gen; Utility/Utility)
 - i. In phase monitor enable/disable
 - j. Phase rotation
 - k. Date and time
- N. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.
- O. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- P. Communications Interface – The controller shall be capable of interfacing, through a standard communications with a network of transfer switches and generators. It shall be able to be connected via an RS-485 serial communication (up to 4000 ft. direct connect or multi-drop configuration), an Ethernet connectivity (over standard 10baseT Ethernet networks utilizing a RJ-45 port or remotely utilizing a dial-up modem). This module shall allow for seamless integration of existing or new communication transfer devices and generators. Monitoring software shall allow for the viewing, control and setup of parameters of the genset and transfer switch network through a standard personal computer utilizing current Microsoft operating systems. Separate and specific transfer switch software interfaces shall not be acceptable.

- Q. The transfer switch shall also be able to interface to 3rd party applications using Modbus RTU and Modbus TCP/IP open standard protocols utilizing Modbus register maps. Proprietary protocols shall not be acceptable.
- R. The controller shall contain a USB port for downloading the controller's parameters and settings; exercise event schedules; maintenance records and event history. The file designator shall be the unique serial number of the transfer switch.
- S. Data Logging – The controller shall have the ability to log data and to maintain the last 2000 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory. The controller shall be able to display up to the last 99 events. The remaining events shall be downloadable to be displayed on a computer.
 - 1. Event Logging – Data, date and time indication of any event.
 - 2. Statistical Data
 - a. Total number of transfers.*
 - b. Total number of fail to transfers.*
 - c. Total number of transfers due to preferred source failure.*
 - d. Total number of minutes of operation.*
 - e. Total number of minutes in the standby source.*
 - f. Total number of minutes not in the preferred source*
 - g. Normal to emergency transfer time
 - h. Emergency to normal transfer time
 - i. System start date
 - j. Last maintenance date

* The statistical data shall be held in two registers. One register shall contain data since start up and the second register shall contain data from the last maintenance reset.
- T. External DC Power Supply – An optional provision shall be available to connect up to two external 12/24 VDC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead for extended periods of time. This module shall contain reverse battery connection indication and circuit protection.

2.09 ACCESSORIES

- A. Supervised Transfer Control Switch – The supervised transfer control switch shall provide a door-mounted, three position, selector switch with Auto, Manual and Transfer positions. The alarm module shall be required in order to activate this option.

1. With the controller set to the automatic mode and the selector switch in the Auto position, the user transfer switch shall operate normally.
 2. With the controller set to the automatic mode and the selector switch in the Manual position, the user shall be required to toggle the selector switch to initiate a transfer from the emergency to the normal position.
 3. With the controller set to the non-automatic mode and the selector switch in the Manual position, the user shall be required to toggle the selector switch to the transfer position to initiate a transfer in either direction. In this mode, the ATS shall not automatically transfer to an acceptable source in the case of source failure, without the user toggling the selector switch to the transfer position.
- B. Heater, Anti-Condensation - An enclosure heater strip shall be supplied inside the transfer switch enclosure and shall be controlled by an adjustable humidistat. The humidistat shall be adjustable from 35% to 95% relative humidity, factory set at 65%. 120VAC power for the strip heater is to be provided by others. A 15A protective circuit breaker is provided. The heater option shall provide 125W or 250W, pending on the configured kit selection.

PART 3 EXECUTION

3.01 FIELD MEASUREMENTS

- A. Contractor shall make all necessary field measurements to verify that equipment shall fit in allocated space in full compliance with minimum required clearances specified in National Electrical Code.

3.02 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall store, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.
- B. Contractor shall inspect and report concealed damage to carrier within 48 hours.
- C. Contractor shall store in a clean, dry space. Cover with heavy canvas or plastic to keep out dirt, water, construction debris, and traffic. Heat enclosures to prevent condensation.
- D. Contractor shall handle in accordance with manufacturer's recommendations to avoid damaging equipment, installed devices, and finish.

3.03 EXAMINATION

A. The following procedures shall be performed by the Contractor.

1. Examine installation area to assure there is enough clearance to install equipment.
2. Check concrete pads for uniformity and level surface.
3. Verify that equipment is ready to install.
4. Verify field measurements are as instructed by manufacturer.
5. Verify that required utilities are available, in proper location and ready for use.
6. Beginning of installation means installer accepts conditions.

3.04 TESTS AND CERTIFICATION

- A. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- B. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, and installation and servicing in accordance with ISO 9001.

3.05 SERVICE REPRESENTATION

- A. The manufacturer shall maintain a national service organization of employing personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

END OF SECTION

SECTION 16425

VARIABLE FREQUENCY DRIVES (VFD)

PART 1 GENERAL

1.01 SCOPE

- A. Variable Speed Motor Controllers, accomplished by a simulated variable frequency voltage to the motor.

1.02 RELATED EQUIPMENT SPECIFIED ELSEWHERE

- A. Section 16170 - Process Control Panels and Hardware
- B. Section 16171 - Panel Mounted Instruments and Devices

1.03 SUBMITTALS

- A. Submit information in accordance with Section 01300 and Section 16010.
- B. Submittals for approval shall include at a minimum the following information:
 - 1. Product Overview
 - 2. Dimensional Drawings
 - 3. Submittal Schedule
 - 4. Circuit Drawings
 - 5. Engineering Data including Weight
 - 6. Clarifications and Exceptions
 - 7. Rating Tables
 - 8. General Notes
 - 9. Warranty Terms

PART 2 PRODUCTS

2.01 GENERAL

- A. Variable frequency drives shall be general purpose variable frequency drives suitable for application within the water / wastewater industry.
- B. The VFD shall be structured as an AC Adjustable Speed Drive (ASD) used to control the speed/torque of the designated motor(s). The Drive shall provide a V/Hz and Sensorless Vector mode of operation.
- C. The manufacturer shall not have less than ten (10) years of experience in adjustable speed drive (ASD) manufacturing.

- D. The manufacturer shall manufacture both AC drives and motors.
- E. The drives shall be manufactured in the United States.
- F. The drives shall be ABB Model ACS550, or equal.

2.02 MOUNTING / ENCLOSURE

- A. The drive shall be freestanding for wall mounting or cabinet installation and suitable for 480V, 60HZ, 3 Phase supply. The unit shall be rated for an IP55 and IP66 isolation class.
- B. Unless otherwise designated, or where limited by the physical size of the equipment, drives shall be mounted internal to the local control panel associated with the equipment being supplied.
- C. Enclosure shall include a circuit breaker disconnect switch associated with the drive. Circuit breakers shall be in accordance with UL 489.
- D. Enclosure door shall include an operator interface for access to drive controller's digital keypad and display.
- E. The operator shall not be required to open the enclosure door to adjust settings, reset faults, or perform other routine functions.
- F. Equip enclosure front with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 16195 - Electrical Identification.
- G. Equip enclosure with phenolic type terminal blocks suitably labeled for all interface of drive and related components.
- H. The drive shall have an air ventilated system, with or without fan driven ventilation having a maximum ambient temperature of up to 40°C (104°F) without derating.
- I. Enclosure shall be equipped to maintain an adequate operating environment for components within. Where required to maintain the enclosure environment within the operating parameters of the drive(s), the enclosure shall incorporate a climate control system (air conditioner). The system shall be configured for the specific application, factoring drive size, enclosure exposure, enclosure NEMA classification and other relevant parameters.

2.03 DRIVE CONSTRUCTION

A. The Drive shall be solid state, with a Pulse Width Modulated (PWM) output. The Drive shall be a Sensorless Vector AC to AC converter utilizing the latest insulated gate bipolar transistor (IGBT) technology. The Drive shall employ a Sensorless Vector inner loop torque control strategy that mathematically determines motor torque and flux. The Drive must also provide an optional operational mode for V/Hz Operation.

B. Ratings

1. The Drive shall be rated to operate from 3-phase power at 208VAC to 600VAC, +10%/-15%, 48Hz to 63Hz. The Drive shall employ a full wave rectifier to prevent input line notching and operate at a fundamental (displacement) input power factor of 0.98 at all speeds and nominal load. The Drive efficiency shall be 98% or better at full speed and load. An internally mounted AC line reactor or DC choke shall be provided to reduce input current harmonic content, provide protection from power line transients such as utility power factor correction capacitor switching transients and reduce RFI emissions. When a DC choke is utilized it shall be of swinging choke design to mitigate harmonics substantially more than conventional choke designs and shall provide equivalent to 5% impedance.
2. The overvoltage trip level shall be a minimum of 30% over nominal, and the under voltage trip level shall be a minimum 35% under the nominal voltage.
3. Output voltage and current ratings shall match the adjustable frequency operating requirements of standard 200-575VAC, 3ph, 60Hz, NEMA Design B motors. The short term normal duty overload current capacity shall be 110% of rated current for one (1) minute out of ten (10) minutes. The short term heavy duty overload current capacity shall be 150% of rated current for one (1) minute out of ten (10) minutes and peak overload capacity shall be 180% for two (2) seconds out of each minute with an instantaneous overcurrent trip at 350% or higher. Output frequency shall be adjustable between 0Hz and 500Hz. Operation above motor nameplate shall require programming changes to prevent inadvertent high-speed operation. The Drive shall be furnished in a UL Type 1 (NEMA 1) listed enclosure rated for operation at ambient temperatures between -15° and 40°C at an altitude not exceeding 3300 feet, with relative humidity less than 95% and no condensation allowed. The Drive shall be protected from atmospheric contamination by Chemical gasses and Solid particles per IEC 60721-3-3; Chemical gasses Class 3C2 and Solid particles Class 3S2. The Drive shall be protected from vibration per IEC 60721-3-3, Class 3M4 (sinusoidal displacement 3.0 mm (0.12 in.), 2Hz to 9Hz; acceleration 10 m/s² (33 ft/s²), 9Hz to 200Hz).

C. Control Functions and Adjustments

1. A start-up assistant will query the operator to provide Start-up data specific to operation of a submersible pump, centrifugal pump/fan and positive displacement pump or compressor. Additional entries shall include motor nameplate power, speed, voltage, frequency and current.
2. A motor parameter ID function shall automatically define the motor equivalent circuit used by the sensorless vector torque controller.
3. Two independent PID speed/torque loop regulators shall be provided with an autotune function as well as manual adjustments.
4. A dynamic braking chopper shall be provided on all models rated up to 15 horsepower 600V and up to 10 horsepower 240V.
5. Carrier frequency shall be adjustable between 1 and 12 kHz up to 200 HP 480V or 150 HP 600V and between 1 and 4 kHz from 250 through 550 HP 480V. The ASD shall automatically adjust the carrier frequency dependent upon Drive temperature and load. Increased temperatures result in automatically decreased switching frequency to ensure continuous operation of the Drive.
6. Start/Stop control functions shall include two (2) or three-(3) wire start/stop, coast/ramp stop selections, optional dynamic braking and flux braking.
7. The ASD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to reference without safety tripping or component damage (flying start). The ASD shall also be capable of flux braking at start to stop a reverse spinning motor prior to ramp.
8. The ASD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable.
9. Accel/Decel control functions shall include two (2) sets of ramp time adjustments with linear and two (2) s-curve ramp selections.
10. Output control functions shall include:
 - a. Current and torque limit adjustments to limit the maximum Drive output current and the maximum torque produced by the motor. These limits shall govern the inner loop torque regulator to provide tight conformance with the limits with minimum overshoot.
 - b. A torque regulated operating mode with adjustable torque ramp up/down and speed/torque limits.
11. The Drive shall have programmable "Sleep" and "Wake up" functions to allow the Drive to be started and stopped from the level of a process feedback signal.

D. Operator Control Panel (Keypad)

1. Each ASD shall be equipped with a front mounted operator control panel (keypad) consisting of a backlit, alphanumeric, graphic display and a

- keypad with keys for Hand, Off and Auto, Up/Down and Help. Two (2) Softkeys will be provided which change functionality depending upon the position within the parameter hierarchy or state of panel.
2. All parameter names, fault messages, warnings and other information shall be displayed in complete English words or Standard English abbreviations to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
 3. The control panel shall provide a real time clock for time stamping events and fault conditions.
 4. The control panel shall include a feature for uploading parameter settings to control panel memory and downloading from the control panel to the same Drive or to another Drive.
 5. All Drives throughout the entire power range shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating.
 6. The keypad is to be used for Hand control, for setting all parameters, and for stepping through the displays and menus.
 7. The keypad shall be removable and capable of remote mounting, and shall have its own non-volatile memory. Remote Keypad to be provided on control panel.
 8. The standard operator panel shall provide a start-up, maintenance and diagnostic assistants that guide a new user through initial start-up and commissioning of the Drive as well as provide indications for maintenance and help to diagnose a fault.
 9. During normal operation, one (1) line of the control panel shall display the speed reference, and run/stop forward/reverse status. The remaining three (3) lines of the display shall be programmable to display the values of any three (3) operating parameters. At least twenty-six (26) selections shall be available including the following:
 - a. Speed/torque in percent (%), RPM or user-scaled units
 - b. Output frequency, voltage, current and torque
 - c. Output voltage, power and kilowatt hours
 - d. Heatsink temperature and DC bus voltage
 - e. Status of discrete inputs and outputs
 - f. Values of analog input and output signals
 - g. Values of PID controller reference, feedback and error signals.
 - h. Control interface inputs and outputs shall be as outlined within the Drawings and Specifications.

E. I/O Capabilities

1. Six (6) digital inputs 12 to 24VDC PNP and NPN, all independently programmable with at least twenty-five (25) input function selections. Inputs shall be designed for "dry contact" inputs used with either an internal or external 24 VDC source.
2. Three (3) form C relay contact digital outputs, all independently

programmable with at least thirty (30) output function selections. Relay contacts shall be rated to switch a maximum two (2) Amps rms continuous current at a maximum switching voltage of 30VDC or 250VAC. Function selections shall include indications that the Drive is ready, running, reversed and at set speed/torque. General and specific warning and fault indications shall be available. Adjustable supervision limit indications shall be available to indicate programmed values of operating speed, speed reference, current, torque and PID feedback.

3. Two (2) analog inputs, each selectable for 0VAC - 10VAC or 4mA - 20mA, and independently programmable with at least ten (10) input function selections. Analog input signal processing functions shall include scaling adjustments, adjustable filtering and signal inversion. If the input reference (4-20mA or 0-10V) is lost, the ASD shall give the user the option of the following: (1) stopping and displaying a fault, (2) running at a programmable preset speed, (3) hold the ASD speed based on the last good reference received, or (4) cause a warning to be issued, as selected by the user. The Drive shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus.
4. Two (2) analog outputs providing 0 (4) to 20mA signals. Outputs shall be independently programmable to provide signals proportional to at least twelve (12) output function selections including output speed, frequency, voltage, current and power.

F. Serial Communications

1. Serial communication interface modules are available for a wide selection of communication protocols. Available adapters are as follows: EtherNet/IP, DeviceNet, Profibus DP, CANopen, ControlNet and PROFINET IO. Communications modules shall be internally mountable. I/O shall be accessible through the serial communications adapter.
2. The ASD shall have an RS-485 port as standard. The standard embedded protocol shall be Modbus RTU.
3. Serial communication capabilities shall include, but not be limited to, run-stop control; speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, and accel/decel time adjustments. The Drive shall have the capability of monitoring feedback such as process variable feedback, output speed/frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), relay outputs, and diagnostic warning and fault information. Additionally, remote Local Area Network (LAN) ASD fault reset shall be possible. A minimum of fifteen (15) field parameters shall be capable of being monitored. The DDC system shall be able to monitor if the motor is running in the ASD mode or bypass mode (if bypass is specified) over serial communications.

G. Protective Functions

1. For each programmed warning and fault protection function, the Drive shall display a message in complete English words or Standard English abbreviations. The three (3) most recent fault messages along with time, current, speed, voltage, frequency and DI Status shall be stored in the Drive's fault history. The last ten (10) fault names shall be stored in Drive memory.
2. The Drive shall include internal MOV's for phase to phase and phase to ground line voltage transient protection.
3. The Drive shall provide electronic motor overload protection qualified per UL508C.
4. Protection shall be provided for AC line or DC bus overvoltage at 130% of max. rated or undervoltage at 65% of min. rated and input phase loss.
5. A power loss ride through feature will allow the Drive to remain fully operational after losing power as long as kinetic energy can be recovered from the rotating mass of the motor and load.
6. Underload protection shall be programmable to provide a warning or stop the Drive after the motor has operated below a selected underload curve for a programmed time limit.
7. Over-temperature protection shall provide a warning if the power module temperature is less than 5°C below the over-temperature trip level.
8. Input terminals shall be provided for connecting a motor thermister (PTC type) to the Drive's protective monitoring circuitry. An input shall also be programmable to monitor an external relay or switch contact.

PART 3 . EXECUTION

3.01 EXAMINATION

- A. Contractor to verify that jobsite conditions for installation meet factory recommended and code required conditions for VFD installation prior to start-up. These shall include as a minimum:
 1. Clearance spacing.
 2. Temperature, contamination, dust, and moisture of the environment.
 3. Separate conduit installation of the motor wiring, power wiring, and control wiring.
- B. Do not install controller until building environment can be maintained with the service conditions required by the manufacturer.

3.02 INSTALLATION

- A. The Contractor shall install the drive in accordance with the recommendations of the VFD manufacturer as outlined in the VFD

installation manual.

1. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers mounted within process control enclosures, coordinate installation with other system components.
 2. The VFD is to be covered and protected from installation dust and contamination until the environment is cleaned and ready for operation. The VFD shall not be operated while the unit is covered.
 3. The installation shall comply with the working, access, and equipment protective space requirements in the NEC - Spaces about Electrical Equipment, including "Dedicated Equipment Space". If it is unavoidable to have foreign systems running above the dedicated space, adequate protection must be installed to avoid damage to the VFD from condensation, leaks, or breaks in such foreign systems.
- B. All electrical power wiring shall be completed by the Electrical Contractor, to NEC wiring requirements based on the VFD input current. The Contractor shall complete all wiring in accordance with the instructions of the VFD manufacturer as outlined in the installation or user's manual. In general, comply with the following:
1. Input power, motor output and control wiring shall each be run in separate conduits.
 2. Use a separate conduit run for each drive.
 3. Motor cables require shielding using conduit, armored cable or shielded cable.
 - a. When using conduit:
 - 1) Bridge joints with a ground conductor bonded to the conduit on each side of the joint.
 - 2) Bond conduit run to the drive enclosure.
 - b. When using armored cable:
 - 1) Use six-conductor (3 phases and 3 grounds), type MC continuous corrugated aluminum armor cable with symmetrical grounds.
 - 2) Armored motor cable can share a cable tray with input power cables, but not with control cables.
 - c. For shielded cable details: Comply with manufacturer's instructions.
 4. For personnel safety, proper operation and to reduce electromagnetic emission/pick-up, the drive and motor shall be properly grounded.
 - a. Motor cables require extra care in grounding and routing in order to reduce parasitic capacitance current leaks that can create noise interference, damage motor bearings or other components.
 5. Check motor and motor cable insulation for adequate resistance per

manufacturer's recommendations.

- a. Disconnect the drive before conducting any voltage tolerance (Hi-Pot) test or insulation resistance (Megger) test on the motor or motor cables. Do not conduct these tests on the drive.

3.03 CONTROL WIRING INSTALLATION AND COORDINATION

- A. The Contractor shall install control wiring between VFDs and remote devices to facilitate operation in accordance with the Drawings and Specifications.
 1. Connect all hard-wired control inputs from SCADA system to VFD.
 2. Connect all hard-wired control outputs (normal/fault indication) from VFD to SCADA system.
- B. Bundle, train, and support wiring in enclosures. Control wiring shall be run in control pathways separated from VFD input and output power wiring.
- C. Connect selector switches and other automatic control devices where applicable.
 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 IDENTIFICATION

- A. Contractor shall identify VFDs, components, driven motor characteristics, and control wiring. Comply with requirements specified in Section 16010 and Section 16195.
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each VFD with engraved nameplate.
 3. Label each enclosure-mounted control and pilot device.
 4. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.
 5. Where specialty enclosures with air filters or other options that need routine inspection and maintenance to ensure proper operation are required for the application, the installing contractor shall provide identification labels requiring preventative maintenance for such units.

3.05 START UP SERVICE

- A. The manufacturer shall provide certified start up service by a factory trained service technician. The service technician shall verify correct installation, start up the drive, and check for proper operation of all features, including interface to the SCADA system. Sales personnel and other agents who are not factory certified technicians for drive field repair shall not be acceptable as commissioning agents. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer. Included in this service shall be (as a minimum):
 - 1. Verification of contractor wire terminations to the VFD and its optional circuitry.
 - 2. Setting of carrier frequency: Select for lowest frequency available that provides acceptable motor audible noise for the application. Lower carrier frequencies generate less heat in the VFD and motor and less potential for undesirable currents through motor shaft bearings.
 - 3. Measurements and verification for proper operation and reliability of the VFD, the motor being driven, and the SCADA system.
 - a. Calibration check for the following set points (and adjustment as necessary) (1) minimum speed (optimized for each application), (2) maximum speed, (3) acceleration and deceleration rates.
 - b. Confirmation of proper installation and functioning of grounding of VFD, motor, and motor shaft.
 - c. Confirm correct settings of control input/output programmed parameters for proper SCADA system interface and control calibration.
 - B. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- 3.06 Compile a thorough list of all specialty enclosures with air filters or other options that need routine inspection and maintenance to ensure proper operation are required for the application. Provide written and/or electronic documentation (signed and dated) to the Owner's representatives during start-up.
- 3.07 WARRANTY
- A. Warranty shall be 24 months from the date of shipment and a minimum of 12 months from the date of substantial completion.

END OF SECTION

SECTION 16427

ELECTRIC ACTUATORS

PART 1 GENERAL

1.01 SCOPE

- A. Electric multi-turn actuators for valves.

PART 2 PRODUCTS

2.01 GENERAL

- A. Actuators shall be designed for valve operation to ensure proper function in accordance to EN 15714-2:2010 electric actuators for industrial valves - basic requirements. Depending on application actuators shall be designed for ON-OFF, short-time duty (S2-15min) respectively Class A and B according to EN 15714-2 or MODULATING, intermittent duty (S4-25%) respectively Class C with up to 1.200 starts per hour; no. of starts depending on actuator size and output speed.
- B. Actuator shall have a design life of 10,000 OPEN-CLOSE-OPEN cycles, each consisting of 30 turns per sense of rotation and must be suitable for operating in any mounting position. Actuator design must provide simple setting, testing, maintenance and repair.
- C. Actuator settings shall be performed non-intrusive via push-buttons at motor control without special tools or instruments (e.g. battery backed setting tool). A wireless Bluetooth interface shall be available. Microsoft Windows™ based software running on a conventional computer shall be available to allow actuator set-up and diagnoses.
- D. Electrical connection of actuators to be multi pin plug and socket connector, allowing quick disconnection in case of maintenance or repair. In order to prevent loss of screws during commissioning or maintenance, all covers shall be fixed with captive screws. In order to minimize the amount of spare parts required, parts such as covers, plug and sockets, parts must be interchangeable throughout all model sizes.
- E. Torque-transmitting housings must be made of cast iron, except motor housing. No plastic parts of any type shall be used, except for electric / electronic components, operating knobs / levers, indicator mechanism and sealing elements as far as applicable.
- F. Depending on valve application, actuators shall be self-locking. Self-

locking shall remain active if actuator is switched to hand-operation-mode. For non self locking actuators with high output speeds a mechanical anti-back drive device shall be provided attached to the actuator.

- G. Valve mounting dimensions shall be according to ISO 5210 with use of a plug sleeve connection adapting to valve shaft. For rising stem applications, actuator design must allow actuator removal from output drive without disturbing the valve function.

2.02 ELECTRIC MOTORS

- A. Motors must be suitable for operating at 3 phase power supply voltage of 480 Volt AC (+/- 10%), 60Hz (+/- 2%) and shall be specifically designed for valve-actuator operation, characterized by high starting torque, low stall torque and low inertia. Motors shall be totally enclosed non ventilated type (TENV). Motor housings and covers to be made of sea water resistant aluminum. Motor-insulation must be in accordance with IEC 85 Class F (155° C). Motors must be protected by 3 thermal monitoring devices, which are embedded in motor windings. Motor connections shall be internal by means of plug and socket.
- B. Motors must be totally separated from lubricant-filled gearing of actuator, allowing replacement of motor without loss of lubricant regardless of mounting position. Motors shall have a dog coupling as mechanical connection to actuators worm shaft.
- C. Actuator motors must develop full torque when power is turned on. All motors shall be of high starting torque type to facilitate 'unseating' of the valve. Each motor shall have a rating plate marked in accordance with IEC 34.1 as far as applicable.

2.03 SIZING

- A. One actuator size (same outside dimensions) shall be available covering output speeds from 4 to 180 rpm for a given torque range, to avoid over sizing and unnecessary weight load on valve stem, flange and yoke. An increase of actuator size caused by higher actuator output speed is not acceptable to avoid weight over sizing of actuators. Actuators must be selected to provide sufficient torque required for safe valve operation. Actuator output torque must be available at 90 % of nominal voltage.
- B. In order to enable proper sizing of applicable electric equipment, actuator supplier has to disclose current value at maximum setting torque. Actuator shall be capable of opening and closing the valve against full differential pressure within specified time on valve data sheet.

2.04 LIMIT AND TORQUE MONITORING

- A. No battery backed limit sensing shall be used to avoid actuator malfunction in case of power failure. Actuators shall have a hall sensor principle based absolute encoder for limit sensing with a resolution of 3° or better. Actuator shall not be equipped with a battery.
- B. Torque sensing shall be of mechanical sliding worm principle with torque values independently settable for 'OPEN' and 'CLOSE' direction. No electronic torque sensing derived from motor current or piezo-electric torque sensing at worm shaft. Torque setting shall be possible for 40% to 100% of rated torque.

2.05 MOTOR AND LOCAL CONTROLS

- A. Integral motor controls shall be microprocessor based and include mechanically and electrically interlocked reversing contactors for ON-OFF duty and solid state contacts (thyristors) for MODULATING duty actuators.
- B. Local controls shall consist of motor controls, push buttons OPEN-STOP-CLOSE-RESET, lockable selector switch LOCAL-OFF-REMOTE and a wireless Bluetooth interface with separate indication showing wireless connection as active, as well as LCD graphic display clearly visible under all lighting conditions with plain text and in world languages, diagnosis symbols, graphs. Five indication lights, available in different color codes, showing status information such as end position open/close, torque fault in both directions and motor protection tripped.
- C. Local controls shall be electrically attached to actuator via plug and socket connection. It shall be possible to re-position local controls at every 90°, so that push buttons and indication lights will face the operator.
- D. In case actuators have to be mounted in difficult to access positions, it shall be possible to separate local controls (including motor controls) from actuator. A wall bracket shall be available to mount local controls / motor controls near valve actuator for distances up to 50 m cable length.
- E. Depending on detailed project design, actuator version shall be as follows:
 - 1. ON-OFF, short-time duty S2-15min with hard wired signals OPEN-STOP-CLOSE, including a 4-20mA output signal, internally powered. Detailed wiring diagram to be supplied with submittal documents.
 - 2. MODULATING, intermittent duty S4-25% with hard wired communication via 4-20mA input signal, including a 4-20mA output signal, internally powered. Detailed wiring diagram to be supplied with submittal documents.

- F. Detailed wiring diagram shall show all relevant signals such as valve position, end positions (OPEN/CLOSE), selector switch position and high torque alarm in OPEN/CLOSE direction. In addition to this, actuator must provide a dedicated fault signal if there is a phase failure, motor protection tripped and/or high torque in OPEN/CLOSE direction or if hand wheel is engaged.
- G. All control signals, communication signals as well as main power supply must be wired to a multi pin plug and socket for customer connection. Terminal compartment shall provide sufficient space to accommodate the possible maximum number of incoming wires. A minimum of three cable entries must be provided for motor power cable and digital/ analogue inputs and outputs. Each cable entry shall be properly sealed by cable glands during site installation. Cable glands shall be chosen by contractor, responsible for wiring during commissioning phase.
- H. Each actuator shall provide an adequately sized internal and external connection for grounding.

2.06 ANTI-CONDENSATION HEATER

- A. In order to prevent condensation, a heater must be installed inside the actuator, suitable for continuous operation. Actuator must provide an alarm signal in case of failure of anti-condensation heater.

2.07 ENCLOSURE

- A. Protection class of actuator, including motor, shall be IP 68, according to EN 60529 against submersion up to 8 m head of water for at least 96 hours. During submersion it must be possible to operate the actuator at least 10 times.

2.08 HANDWHEEL

- A. Actuators must be equipped with a hand wheel for manual operation. Clockwise operation of hand wheel shall cause clockwise movement of output drive. Hand wheel shall be clearly marked with an arrow and the word 'CLOSE'.
- B. Hand wheel engagement shall be of spring loaded push mechanism type and required manual declutching. Actuator must provide a switch signal when in manual mode.
- C. Under manual operation, hand wheel shall drive the worm shaft. Self locking shall be maintained in hand operation. Motor must be disengaged during manual operation. Hand wheel shall automatically disengage when

the electric motor is energized.

- D. Hand wheel must be sized allowing easy manual operation of output drive. The over torque indication shall be active in manual operation as well as motor operation, thus allowing a signal to be provided when the set-torque has been reached.

2.09 BEARINGS AND GEARS

- A. Bearings shall be of antifriction or self-lubricating type. Bearings shall not require any maintenance between general overhauls. Power gears shall be made from heat treated steel. Worm-wheels shall be made of bronze material. Actuator gear housing shall be filled with an adequate quantity of lubricant. Re-lubrication between general overhauls shall not be required.

2.10 NOISE LEVEL

- A. Under all operating conditions the noise level of actuators shall not exceed 75 dB(A) at 1 m.

2.11 NAME PLATES

- A. Two nameplates, made of aluminum, shall be attached to each actuator; one on the motor housing, showing all relevant motor data, one on the actuator housing showing all relevant actuator data. Special information, such as valve tag no., shall be shown if required. Nameplates shall be securely fixed to actuator and motor, so that they cannot be removed or scratched off during shipment, installation, operation or maintenance.

2.12 PAINTING AND CORROSION PROTECTION

- A. Actuator corrosion protection shall fulfill the requirements of EN ISO 12944-2, classification of environments C4 with a specified salt spray test of 720h. Actuator painting must be performed in such a way, that no corrosion takes place under ambient conditions as specified. All outside screws or bolts shall be made of stainless steel (A2). Actuators shall be corrosion protected with a primer coating and a two layer powder coating consisting of an epoxy coating and a polyurethane top coating with a total film thickness of at least 140µm. Final color shall be silver grey similar to RAL 7037.

2.13 ACCESSORIES

- A. The actuator shall include a removable torque or thrust bushing to mate with the valve shaft.

- B. Diagnostic facilities shall be included to accumulate and report the performance of the motor, encoder, contactor, cycle time, hand wheel operations, actuator ID, firmware revision, and output turns. In addition, a torque profile of the reference baseline valve stroke and the last valve stroke shall be included. A feature for reset shall be provided. All diagnostic information shall be displayed on the LCD. Diagnostics shall also include a Frequency Domain Analysis (FDA) feature. The FDA methodology shall capture torque, position or speed values at regular time intervals while the actuator is motoring, and calculate the resulting data set with a Fast Fourier Transform (FFT). The resulting information shall be used to isolate any components in the mechanical drive train that may exhibit excessive wear or may affect normal actuator operation. FDA and resultant fault indications shall be displayed via the graphical LCD. The actuator shall contain the ability for diagnostics information to be downloaded to a PC or PDA via both IRDA and Bluetooth ports.
- C. Analog Position Transmitter (APT) - A non-contacting, internally powered, electrically isolated position transmitter shall be included to provide a 4-20 mA signal that is proportional to valve position.
- D. Power Interruption Switch - A disconnect switch (load break switch), rated 20 A at 600 VAC, shall be provided to isolate the actuator from the three-phase supply. The switch shall be suitable for breaking motor locked rotor amperage. The disconnect switch shall be enclosed in its own NEMA 4X, housing that is separate from all other actuator components. The disconnect housing can be coupled to an actuator conduit entry and the power wires connected from the disconnect to the actuator terminal block. Site wiring shall be direct to the disconnect switch which shall be accommodated by a 1.25" NPT conduit entry in the disconnect housing. All connection terminals shall be shrouded and the switch shall be padlockable in either position.

2.14 MANUFACTURER / MODEL

- A. The actuator shall be Limitorque MX as manufactured by Flowserve Corp., Lynchburg, VA, SA 10.2/SAR 10.2 as manufactured by Auma, Inc., a comparable unit manufactured by Rotork, Inc., or approved equal.

PART 3 EXECUTION

3.01 GENERAL

- A. Factory testing - Every actuator shall be factory tested to verify: rated output torque, output speed, handwheel operation, local control, control power supply, valve jammed function, all customer inputs and outputs, motor current, motor thermistor, LCD and LED operation, direction of

rotation, microprocessor checks, and position-sensor checks. A report confirming successful completion of testing shall be included with the actuator.

3.02 VALVE INTERFACE

- A. Contractor shall provide all coordination required to assure correct interface and operation of the actuator and related valve. This shall include, but not be limited to, torque requirements of the valve, shaft/nut configuration and clearances within the valve pit required for the valve/actuator combination.

3.03 ELECTRICAL REQUIREMENTS

- A. Contractor shall provide electrical supply required to operate the actuator(s) as outlined in the Drawings.
- B. Electrical supply and secondary wiring shall be installed in accordance with the requirements of Division 16.

3.04 ACTUATOR SCHEDULE

- A. The following schedule shall be utilized to supply electric actuators on this project.

<u>Location</u>	<u>Valve</u>	<u>Actuator Type</u>	<u>Operation</u>
WAS Discharge	3" Pinch Valve	Multi-turn	Modulating
RAS Discharge	4" Plug Valve	Multi-turn	Modulating

END OF SECTION

SECTION 16451

DRY-TYPE TRANSFORMERS, 5-500 KVA

PART 1 GENERAL

1.01 SCOPE

- A. Transformers designed for lighting and general power application.

1.02 SUBMITTALS:

- A. Refer to Section 01300 for submittal procedure.
- B. Provide shop drawing showing transformer dimensions, weight, service access requirements and electrical requirements.
- C. Provide manufacturer's instructions, indicate installation and support requirements.
- D. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list. Contact names and information for parts and assistance shall also be provided.

1.03 COORDINATION

- A. Coordinate sizes and locations of supports required for transformers.

1.04 FIELD CONDITIONS

- A. Handling and Storage: Handle and store equipment in accordance with manufacturer's published instructions. Examine units upon delivery for damage. Store units protected from weather.

1.05 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to furnish replacement equipment for units that demonstrate defects in workmanship or materials under normal use within warranty period specified.

- 1. Warranty Period: 12 months from date of substantial completion.

PART 2 PRODUCTS

2.01 SIZES 5 - 25 KVA

A. Electrical

1. Voltage and capacity ratings as shown on the Drawings. 60 Hz.
2. Isolated windings.
3. Two 2-1/2% taps above and two 2-1/2% taps below rated primary voltage.
4. Impedance: Min. 3%, max. 5%.

B. Insulation 185°C, 115°C temperature rise.

C. Enclosure: Weatherproof indoor/outdoor type. Sealed or encapsulated windings. Weatherproof terminal compartment. Phosphatized, primed, and baked enamel finish on enclosure metal.

D. Sound Level: 40 db, measured by applicable ANSI Standards.

2.02 SIZES 30 - 500 KVA

A. Electrical

1. Voltage and capacity ratings as shown on the Drawings. 60 Hz.
2. Core grounded to enclosure grounding lug by flexible conductor.
3. Isolated windings.
4. Two 2-1/2% taps above and four 2-1/2% taps below rated primary voltage.
5. Impedance: Min. 4%, max. 5%.

B. Insulation 220°C, 150°C temperature rise.

C. Enclosure: Ventilated dust and drip protected. Sealed windings with fiberglass coating for physical protection. Phosphatized, primed, and baked enamel finish on enclosure metal.

D. Sound Level: (Measured by applicable ANSI Standards)

1. 30 - 50 KVA: 45 db
2. 75 - 500 KVA: 50 db

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount transformers where indicated on Drawings.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall furnish and install the panelboards as specified and as shown on the Drawings.

1.02 REFERENCES

- A. The panelboards and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA and UL as follows:

1. UL 67 – Panelboards
2. UL 50 – Cabinets and boxes
3. NEMA PB1
4. Fed. Spec. W-P-115C
5. Circuit breaker – Type I class I
6. Fusible switch – Type II class I

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300 and Section 16010.
- B. Shop Drawings:
 1. Clearly present sufficient information to determine compliance with Drawings and Specifications.
 2. The following information shall be submitted to the Engineer:
 - a. Breaker layout drawing with dimensions indicated and nameplate designation
 - b. Component list
 - c. Conduit entry/exit locations
 - d. Assembly ratings including:
 - 1) Short-circuit rating
 - 2) Voltage
 - 3) Continuous current
 - e. Cable terminal sizes
 - f. Product data sheets

1.04 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.05 REGULATORY REQUIREMENTS

- A. The panelboards shall be UL labeled.

1.06 DELIVERY, STORAGE AND HANDLING

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

1.07 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Eaton
- B. Siemens
- C. Or equal
- D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.02 RATINGS

- A. Panelboards rated 240 VAC or less shall have short-circuit ratings as

shown on the drawings or as herein scheduled, but not less than 10,000 amperes RMS symmetrical.

- B. Panelboards rated 480 VAC shall have short-circuit ratings as shown on the drawings or as herein scheduled, but not less than 14,000 amperes RMS symmetrical.
- C. Panelboards shall be labeled with a UL short-circuit rating. When series ratings are applied with integral or remote upstream devices, a label or manual shall be provided. It shall state the conditions of the UL series ratings including:
 - 1. Size and type of upstream device
 - 2. Branch devices that can be used
 - 3. UL series short-circuit rating

2.03 CONSTRUCTION

- A. Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
- B. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi flush cylinder lock and catch assembly. Door-in-door trim shall be provided. Both hinged trim and trim door shall utilize three point latching. No tools shall be required to install or remove trim. Trim shall be equipped with a door-actuated trim locking tab. Equip locking tab with provision for a screw such that removal of trim requires a tool, at the owner's option. Installation shall be tamper resistant with no exposed hardware on the panelboard trim.
- C. Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.
- D. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
- E. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.
- F. All locks shall be keyed alike.

2.04 BUS

- A. Main bus bars shall be copper sized in accordance with UL standards to

limit temperature rise on any current carrying part to a maximum of 65 degrees C above an ambient of 40 degrees C maximum.

- B. A ground bus shall be included in all panels.
- C. Full-size (100%-rated) insulated neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection. 200%-rated neutrals shall be supplied for panels designated on drawings with oversized neutral conductors.

2.05 BRANCH CIRCUIT PANELBOARDS

- A. The minimum short-circuit rating for branch circuit panelboards shall be as specified herein or as indicated on the Drawings. Panelboards shall be fully rated. Panelboards shall be Eaton type Pow-R-Line 1a, Pow-R-Line 2a or Pow-R-Line 3a, or equal.
- B. Bolt-on type, heavy-duty, quick-make, quick-break, single- and multi-pole circuit breakers of the types specified herein, shall be provided for each circuit with toggle handles that indicate when unit has tripped.
- C. Circuit breakers shall be thermal-magnetic type with common type handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame and through 100-ampere trip sizes shall take up the same pole spacing. Circuit breakers shall be UL listed as type SWD for lighting circuits.
 - 1. Circuit breaker handle locks shall be provided for all circuits that supply exit signs, emergency lights, energy management, and control system (EMCS) panels and fire alarm panels.
- D. Circuit breakers shall have a minimum interrupting rating of 10,000 amperes symmetrical at 240 volts, and 14,000 amperes symmetrical at 480 volts, unless otherwise noted on the drawings.

2.06 DISTRIBUTION PANELBOARDS – CIRCUIT BREAKER TYPE

- A. Distribution panelboards with bolt-on devices contained therein shall have interrupting ratings as specified herein or indicated on the drawings. Panelboards shall be fully rated. Panelboards shall be Eaton type Pow-R-Line 3a or Pow-R-Line 4B or equal. Panelboards shall have molded case circuit breakers as indicated below.
- B. Where indicated, provide circuit breakers UL listed for application at 100%

of their continuous ampere rating in their intended enclosure.

- C. Provide shunt trips, bell alarms, and auxiliary switches as shown on the Drawings.

2.07 MAIN AND FEEDER PROTECTIVE DEVICES

- A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics and shall be Eaton or approved equal.
- B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
- C. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the Drawings.
- D. Circuit breakers 800-ampere frame and below shall be have thermal-magnetic trip units and inverse time-current characteristics.
- E. Ground fault protection shall be provided where indicated.
- F. Where indicated circuit breakers shall be UL listed for series application.
- G. Where indicated circuit breakers shall be current limiting.
- H. Where indicated provide UL listed circuit breakers for applications at 100% of their continuous ampere rating in their intended enclosure.

2.08 MAIN LUGS

- A. Main Lugs Only Interiors: Provide double lugs (sub-feed) on all "Main Lugs Only" type panelboards. Through-feed lugs may be provided if installation arrangement is more suitable.

2.09 ENCLOSURE

- A. Enclosures shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior

mounting studs with adjustable nuts shall be provided.

B. Enclosures shall be provided with blank ends.

C. Where indicated on the Drawings, branch circuit panelboards shall be column width type.

2.10 NAMEPLATES

A. Provide an engraved nameplate for each panel section.

2.11 FINISH

A. Surfaces of the trim assembly shall be properly cleaned, primed, and a finish coat of gray ANSI 61 paint applied.

PART 3 EXECUTION

3.01 FACTORY TESTING

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

3.02 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's recommendations and the Drawings.

B. Install panels with top at 6'-0" above floor / adjacent grade unless otherwise noted on the Drawings.

C. Coordinate location of flush panels with other concealed work.

END OF SECTION

SECTION 16471

DISTRIBUTION PANELS

PART 1 GENERAL

1.01 SCOPE

- A. Exterior distribution circuit breaker panelboards primarily for lighting and receptacles, and other single phase loads, with mains up to 225 amperes.

1.02 UL LISTING

- A. Distribution panels shall be listed by Underwriters Laboratories for short circuit current rating, circuit breaker ratings, bussing temperature rise, and enclosure.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with Drawings and Specifications.
 - 2. The following information shall be submitted to the Engineer:
 - a. Breaker layout drawing with dimensions indicated and nameplate designation
 - b. Component list
 - c. Conduit entry/exit locations
 - d. Assembly ratings including:
 - 1) Short-circuit rating
 - 2) Voltage
 - 3) Continuous current
 - e. Cable terminal sizes
 - f. Product data sheets

PART 2 PRODUCTS

2.01 MANUFACTURER / MODEL:

- A. Provide industrial panelboards with associated main and feeder breaker assemblies as follows:
 - 1. Crouse-Hinds Model XLPB
 - 2. Comparable product by Siemens

3. Or equal.

- B. Panelboard ratings (voltage, phase, panel size) shall be as outlined on the Drawings.

2.02 ENCLOSURE

- A. Panelboard enclosure shall be designed as an "industrial panelboard" and suitable for exterior surface mount applications.
- B. Panelboard shall incorporate heavy-duty welded mounting feet and a dead front.
- C. Panelboard shall incorporate a high quality foam-in-place gasket to prevent against ingress of water and corrosive agents. The panel door shall incorporate an integral drainage channel to prevent intrusion of moisture / dust from the top side of the panel. Door shall be hinged.
- D. Enclosure shall be rated NEMA 4X and shall be constructed of 316L stainless steel.
- E. Panel entry shall incorporate SS316L quarter-turn screw driver entry latches.
- F. Panel shall be equipped with option for bottom feed of conductors.
- G. Wiring space shall be adequate for bending of the largest conductors.
- H. Panel shall incorporate a circuit schedule mounted on the interior of the door. Panel shall incorporate an interior stamped metal plate identifying voltage, main amperes, short circuit rating, manufacturer, and model.
- I. Exterior of the panel shall be identified via an embossed plate as outlined in Section 16195.

2.03 CIRCUIT BREAKERS

- A. Branch Breakers: Thermal-magnetic molded, case unless otherwise indicated. Magnetic trip approximately 10X continuous rating. Ratings as indicated.
- B. Main Breakers: shall have electronic trips, with selectable Instantaneous function that may be turned OFF for coordination purposes; selectable and adjustable ground fault function and over-current amplitude and time delays.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Mount panels and complete wiring interface in accordance with manufacturer's instructions.
- B. Install panels with top at 6'-0" above adjacent grade unless otherwise noted on the Drawings.
- C. Coordinate exterior labeling of panelboard with Owner prior to installation of identification.

3.02 SPARE PARTS

- A. Incorporate into the panelboard the noted number of spare circuit breakers at the designated ratings as shown on the Drawings.

END OF SECTION

SECTION 16510

INTERIOR LIGHTING

PART 1 GENERAL

1.01 SCOPE

- A. This section specifies the furnishing, installation, and connection of interior luminaires and supports.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01300 and Section 16010.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with drawings and specifications.
 - 2. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, poles, luminaires, lamps, and accessories.
- C. Manuals: Two weeks prior to final inspection, submit four copies of operating and maintenance manuals to the Engineer. Include technical data sheets, wiring and connection diagrams, and information for ordering replacement lamps, ballasts, and parts.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Provide manufacturer's standard provisions for fixtures during transport, storage, and installation. Do not store fixtures on ground.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide the sizes and types shown on the Drawings, complete with all necessary lamps, and accessories.
- B. Materials and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the Drawings and specified.
- C. Where designated, equip fixtures with emergency back-up circuitry.

2.02 LED HI BAY / WET LOCATION FIXTURES

- A. Construction: Fixture housing shall be two-piece die cast aluminum, clamshell design. Top and bottom housing shall be sealed with silicone gasket to ensure appropriate fit.
- B. Optics: Fixture shall incorporate high-brightness LED arrays mounted on metal core circuit boards, with heat and impact resistant tempered clear glass for protection. Lumen output shall be as outlined within the Fixture Schedule on the Drawings.
- C. Listing: Fixture shall be UL listed for wet locations. IP66 rated.
- D. Electrical: LED drivers mounted to die-cast aluminum housing for optimal heat dissipation and cool running operation. Projected life shall be 60,000 hours at 70% lumen maintenance. Voltage shall be as outlined in the Fixture Schedule on the Drawings.
- E. Mounting: Mounting method and accessories shall be as outlined in the Fixture Schedule on the Drawings.
- F. Finish: Housing and adapter shall be protected with epoxy powder coat paint.

2.03 LED HI BAY / HAZARDOUS LOCATION FIXTURES

- A. Listing: Fixture shall be listed for installation within Class 1, Division 1, Group D locations.
- B. Optics: Fixture shall incorporate high-brightness LED arrays mounted on metal core circuit boards, with heat and impact resistant tempered clear glass for protection. Lumen output shall be as outlined within the Fixture Schedule on the Drawings.
- C. Electrical: LED drivers mounted to housing for optimal heat dissipation and cool running operation. Projected life shall be 50,000 hours at 70% lumen maintenance. Voltage shall be as outlined in the Fixture Schedule on the Drawings.
- D. Mounting and Accessories: Mounting method and accessories shall be as outlined in the Fixture Schedule on the Drawings.

2.04 LED INDUSTRIAL WET LOCATION LINEAR FIXTURE

- A. Construction: Fiberglass housing with injection molded impact resistant frosted acrylic lens and poured in place gasket seals. Equip with stainless steel latches.

- B. Classification: Hose down & wet location fixture shall conform to IP65 and IP66.
- C. Optics: Fixture shall incorporate high-brightness LED arrays mounted on metal core circuit boards. Lumen output shall be as outlined within the Fixture Schedule on the Drawings.
- D. Electrical: Long-life LEDs at L80 (80% lumen maintenance) at 60,000 hours. Power Factor shall be greater than 0.90 at full load. Voltage shall be as outlined in the Fixture Schedule on the Drawings.
- E. Color: Color Rendering Index (CRI) > 80.
- F. Mounting and Accessories: Mounting method and accessories shall be as outlined in the Fixture Schedule on the Drawings.

2.05 LED INDUSTRIAL HAZARDOUS LOCATION LINEAR FIXTURE

- A. Listing: Fixture shall be listed for installation within Class 1, Division 1, Group D locations.
- B. Construction:
 - 1. LED housing assembly and heat sink shall be of extruded aluminum with low copper content for corrosion protection and heat dissipation.
 - 2. LED board assembly lens cover shall be made of heat and impact resistant glass. Diffused options need to be available for glass.
 - 3. Fixture shall utilize nitrile type gaskets between the driver and LED housing as well as the lens cover and LED board for ingress protection against dust and water.
 - 4. Fixtures must not contain mercury or any other hazardous chemicals.
 - 5. Diffused lens options for glass must be available for applications requiring low glare.
 - 6. Fixture shall have external surface of low copper aluminum and nitrile type gaskets between the lens and LED board assembly, driver and LED housing for protection against acids (including acetic acid), sulfur, water (liquid and vapor form), hydrocarbons, and chlorine.
 - 7. The fixture design must have serviceable drivers accessible from the bottom of fixture and field replaceable without removing the fixture from a ceiling or wall mount installation.
 - 8. The power supply or driver must be located in line with LED boards and not on top of them to maximize thermal dissipation and maintain lower driver baseplate temperatures
- C. Electrical Requirements:
 - 1. Standard input driver voltage of 100-277 VAC, 50/60 Hz.

2. Power factor >0.95 @ 277 VAC and THD <20% @ 277 VAC.
3. System efficiency: minimum of 115 lumens per watt (LPW) for standard glass lens 4ft 100-277 VAC fixtures.
4. Drivers must have an L10 reliability of a minimum of 60,000 hours @ 55°C ambient (i.e. no more than 10% of drivers installed in the field may fail catastrophically in the above specified duration and temperature range).

D. Optics:

1. Fixture shall incorporate high-brightness LED arrays mounted on metal core circuit boards. Lumen output shall be as outlined within the Fixture Schedule on the Drawings.
2. The fixture shall have standard wide (120 degree) optic.
3. Fixtures should have a minimum efficacy of 115 lumens/watt @ 100-277 VAC.

E. Color: Fixtures shall have a minimum CRI of 70 @ 5000K and L70 > 400,000 @ 65°C ambient.

F. Mounting and Accessories: Mounting method and accessories shall be as outlined in the Fixture Schedule on the Drawings.

2.06 LED WET LOCATION WALL FIXTURE

A. Construction: Impact resistant polycarbonate housing with injection molded impact resistant clear polycarbonate lens designed for wall mounting.

B. Certification: Fixture shall be UL listed for installation in wet locations.

C. Electrical Requirements:

1. Standard input driver voltage of 100-277 VAC, 50/60 Hz.
2. Non-dimmable.
3. System efficiency: minimum of 70 lumens per watt (LPW).

D. Color: Fixtures shall have a minimum CRI of 82 @ 4000K.

2.07 LED FLUSH MOUNT FIXTURE

A. Construction: Aluminum housing with matte white acrylic diffuser designed for ceiling mounting.

B. Certification: Fixture shall be UL listed for installation in wet locations.

C. Electrical Requirements:

1. Standard input driver voltage of 120 VAC, 50/60 Hz.
2. Non-dimmable.
3. System efficiency: minimum of 70 lumens per watt (LPW).

D. Color: Fixtures shall have a minimum CRI of 80 @ 4000K.

2.08 LED VAPORPROOF JELLY JAR FIXTURE

A. Construction: Aluminum housing with clear polycarbonate lens designed for wall or ceiling mounting.

B. Certification: Fixture shall be UL listed for installation in wet locations, IP66.

C. Electrical Requirements:

1. Standard input driver voltage of 120-277 VAC, 50/60 Hz.
2. Power factor >0.9 @ 277 VAC and THD <25% @ 277 VAC.
3. Non-dimmable.
4. System efficiency: minimum of 80 lumens per watt (LPW).
5. Drivers must have an L70 reliability of a minimum of 50,000 hours @ TM-21 standards, 25°C.
6. Operating temperature range: -30° F. to 104°F.

D. Color: Fixtures shall have a minimum CRI of 70 @ 5000K.

E. Mounting and Accessories: Mounting method and accessories shall be as outlined in the Fixture Schedule on the Drawings.

PART 3 EXECUTION

3.01 FIXTURE MOUNTING

A. Suspended: Pendant mount, using 1/2 inch conduit stem, rod, or cable as specified on the Drawings.

B. Surface: Attach to appropriate work box or bracket.

C. Recessed: normal support is attachment to or lay-in on the ceiling support system. In addition, provide one *safety* cable support, so that in case of ceiling failure the fixture will not drop more than one inch. The safety support shall prevent strain on electrical components and wiring.

D. Mounting Heights: as indicated on the Drawings.

- E. Location: approximately where shown on the Drawings. Avoid serious obstructions to the light pattern. Do not mount in such a way that maintenance is made difficult. Avoid interference with equipment and piping.

3.02 INSTALLATION

- A. Install fixtures level, with no gaps between adjacent fixtures or between fixtures and surrounding surfaces. Lenses, reflectors, and trims of fixtures shall be properly and uniformly aligned.
- B. Connect night light fixtures and emergency lighting fixtures to the hot (unswitched) side of lighting circuits.
- C. Provide an individual feed with ground conductor from a junction box to each lighting fixture. Lighting fixtures shall not be daisy-chained.
- D. Drops to recessed fixtures may be flexible metallic conduit, or manufactured wiring systems may be used where accessible. Fixtures shall be provided with sufficient length to permit removal and lowering of the fixtures 12" below the ceiling.
- E. Provide green grounding conductors back to the panel ground for lighting circuits. Raceways shall not be used as grounding conductors.
- F. Fixtures shall have their exterior labels removed and shall be thoroughly cleaned. Burned out lamps shall be replaced.
- G. Locate emergency lighting remote battery packs and remote test/monitor modules identically so their status indicating lights are visible to the public and they form a straight line when viewed from the end of the corridor or room. Where a suspended ceiling exists, center the status indicating lights in adjacent ceiling tiles.

3.03 FIELD QUALITY CONTROL

- A. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures. Misalignment and light leaks shall be corrected, and rattles due to miscellaneous vibration shall be eliminated.
- B. Perform an operational test to verify that all fixtures illuminate properly, dimming systems dim properly (i.e. no flicker), and lighting zones are switched according to the Drawings.

END OF SECTION

SECTION 16520

EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SCOPE

- A. This section specifies the furnishing, installation, and connection of exterior luminaires, poles, and supports.

1.02 SUBMITTALS

- A. Submit in accordance with Section 01300 and Section 16010.
- B. Shop Drawings:
 - 1. Clearly present sufficient information to determine compliance with Drawings and Specifications.
 - 2. Include electrical ratings, dimensions, mounting, details, materials, required clearances, terminations, wiring and connection diagrams, photometric data, ballasts, poles, luminaires, lamps, and accessories.
- C. Manuals: Two weeks prior to final inspection, submit four copies of operating and maintenance manuals to the Engineer. Include technical data sheets, wiring and connection diagrams, and information for ordering replacement lamps, ballasts, and parts.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Provide manufacturer's standard provisions for protecting pole finishes during transport, storage, and installation. Do not store poles on ground. Store poles so they are at least 12 in above ground level and growing vegetation. Do not remove factory-applied pole wrappings until just before installing pole.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide the sizes and types shown on the Drawings, complete with all necessary poles, lamps, and accessories.
- B. Materials and equipment shall be in accordance with NEC, UL, ANSI, and as shown on the Drawings and specified.
- C. Where designated, equip fixtures with emergency back-up circuitry.

2.02 POLES

A. General:

1. Poles shall be as shown on the drawings, and as specified. Finish shall be as specified on the drawings.
2. The pole and arm assembly shall be designed for wind loading of 100 mph, with an additional 30% gust factor, supporting luminaire(s) and accessories such as shields, banner arms, and banners that have the effective projected areas indicated. The effective projected area of the pole shall be applied at the height of the pole base, as shown on the drawings.
3. Poles shall be embedded type designed for use with underground supply conductors.
4. Hardware and Accessories: All necessary hardware and specified accessories shall be supplied.

B. Material:

1. All poles shall be Southern Yellow Pine.
2. All poles shall conform in all respects to the latest revision of the American National Standard Association Specification 05.1 entitled "Specifications and Dimensions for Wood Poles".
3. All poles shall be machine turned. Turning, boring (if required) and roofing shall be done before treatment.

C. Preservative Treatment:

1. Poles shall be cured and have all manufacturing processes completed prior to treatment.
2. Poles shall be cured and treated full length in accordance with the latest revision of the
3. American Wood Preservers Association (AWPA) guidelines as published in the latest revision of the APWA Book of Standards. Treatment shall be accomplished using Chromated Copper Arsenate, with methods, preparation and solvents as directed in the AWPA Book of Standards.

2.03 LUMINAIRES - GENERAL

- A. Per UL 1598 and NEMA C136.17. Luminaires shall be weatherproof, heavy duty, outdoor types designed for efficient light utilization, adequate dissipation of lamp and ballast heat, safe cleaning and relamping.

- B. Light distribution pattern types shall be as shown on the Drawings.

- C. Where ballasts are required, incorporate ballasts in the luminaire housing, except where otherwise shown on the Drawings.
- D. Lenses shall be frame-mounted, heat-resistant, borosilicate glass, with prismatic refractors, unless otherwise shown on the Drawings. Attach the frame to the luminaire housing by hinges or chain. Use heat and aging-resistant, resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- E. Pre-wire internal components to terminal strips at the factory.
- F. Bracket-mounted luminaires shall have leveling provisions and clamp-type adjustable slip-fitters with locking screws.
- G. Materials shall be rustproof. Latches and fittings shall be non-ferrous metal.
- H. Provide manufacturer's standard finish as scheduled on the Drawings.
- I. Luminaires shall carry factory labels, showing complete, specific lamp and ballast information.

2.04 LED FIXTURES

- A. Enclosure and trim for fixtures shall be as specified in the Fixture Schedule on the Drawings.
- B. LEDs: As specified in the Fixture Schedule. All fixtures shall have LEDs operating at new intensity at time of project acceptance.
- C. Where designated, exterior building mounted light fixtures shall be controlled via a master photocell. The photocell shall be "turn-lock" type, Tork 50015-2223 or equal. The photocell shall be mounted in the location as shown on the Drawings.
- D. All exterior luminaires shall be "Dark Sky" compliant.
- E. Exterior building mounted light fixtures below 12'-0" shall have full cut-off optics unless otherwise designated.
- F. Exterior building mounted light fixtures mounted at or above 12'-0" may be cut-off, adjustable flood, or wall-pack.
- G. Wall pack light fixtures shall have a die-cast housing, borosilicate prismatic glass refractor or full cutoff door (as designated), and shall be

completely gasketed. Where noted in the Fixture Schedule the units shall be equipped with battery back-up, battery back-up (cold temperature) and wire guards.

2.05 LAMPS

- A. Install the proper lamps / drivers in every luminaire.
- B. Lamps / drivers shall be general-service, outdoor lighting types.
- C. Voltage shall be as shown on the Drawings.
- D. LED sources shall meet the following requirements:
 - 1. Operating temperature rating shall be between -40° F and 120° F.
 - 2. Correlated Color Temperature (CCT): As shown within the Fixture Schedule on the Drawings.
 - 3. Color Rendering Index (CRI): ≥ 65 .

2.06 LED DRIVERS

- A. LED drivers shall meet the following requirements:
 - 1. Drivers shall have a minimum efficiency of 85%.
 - 2. Starting Temperature: -40° F.
 - 3. Input Voltage: 120 to 480 ($\pm 10\%$) V.
 - 4. Power Supplies: Class I or II output.
 - 5. Surge Protection: The system must survive 250 repetitive strikes of "C Low" (C Low: 6kV/1.2 x 50 μ s, 10kA/8 x 20 μ s) waveforms at 1-minute intervals with less than 10% degradation in clamping voltage. "C Low" waveforms are as defined in IEEE/ASNI C62.41.2-2002, Scenario 1 Location Category C.
 - 6. Power Factor (PF): ≥ 0.90 .
 - 7. Total Harmonic Distortion (THD): $\leq 20\%$.
 - 8. Comply with FCC Title 47 CFR Part 18 Non-consumer RFI/EMI Standards.
 - 9. Drivers shall be reduction of hazardous substances (ROHS)-compliant.

2.07 ACCESSORIES – POLE MOUNED FIXTURES

- A. Mast Arm(s): Provide cast aluminum mast arms for mounting of the designated luminaires. Mounting height and configuration shall be as designated in the Fixture Schedule on the Drawings.
- B. Lighting Pole Riser Cable: Provide lighting pole riser cables to connect the luminaires to the "Y" connector kits installed on the conductors in the base of the poles. The riser cables shall consist of copper conductors with

Type USE, thermosetting cross-linked polyethylene (XLP) insulation rated for 600V. The minimum size of the conductors shall be #10 AWG.

- C. Photo Control: Where designated in the Fixture Schedule on the Drawings, incorporate a photo control receptacle within the fixture and provide the requisite control components to facilitate operation.

PART 3 EXECUTION

3.01 GENERAL

- A. Install fixtures, poles and accessories in accordance with the manufacturer's instructions.

3.02 WOODEN POLE INSTALLATION

- A. A hole to receive the pole shall be prepared to the depth indicated on the Drawings. Concrete sidewalks shall be saw cut.
- B. The pole shall be set in the hole and held straight and true.
- C. The hole shall be backfilled in six inch layers and firmly tamped, using a powered tamper.
- D. The excess earth and materials shall be disposed of by the Contractor as outlined on the Drawings and in the specifications.
- E. If the pole is set in a concrete sidewalk the section of the sidewalk shall be replaced in accordance with these specifications.
- F. If the pole is set in a brick sidewalk or other paved area, the surface shall be restored with similar materials, as shown on the Drawings and as directed by the Engineer.
- G. The location of the poles shall be as shown on the Drawings and as located in the field by the Engineer.
- H. The Engineer may direct any pole to be topped after installation. Any poles so topped shall have their roofs protected by a plastic pole cap.

3.03 FIXTURE MOUNTING

- A. Mounting Heights: As indicated on the Drawings.
- B. Location: Approximate where shown on the Drawings. Avoid serious obstructions to the light pattern. Do not mount in such a manner that

maintenance is made difficult. Avoid interference with equipment and piping.

- C. Mount fixture to wall, on mast arm or in other manner as designated on the Drawings. Follow manufacturer's instructions for mounting of fixture.
- D. Install lamps in each luminaire.
- E. Adjust luminaires that require field adjustment or aiming.

3.04 GROUNDING

- A. Ground noncurrent-carrying parts of equipment, including metal poles, luminaires, mounting arms, brackets, and metallic enclosures, as specified in Section 16015, Electrical Grounding. Where copper grounding conductor is connected to a metal other than copper, provide specially-treated or lined connectors suitable and listed for this purpose.

3.05 ACCEPTANCE CHECKS AND TESTS

- A. Verify operation after installing luminaires and energizing circuits.

END OF SECTION

SECTION 16530

EMERGENCY LIGHTING

PART 1 GENERAL

1.01 SCOPE

- A. Exit Lights
- B. Emergency Lighting

1.02 RELATED EQUIPMENT SPECIFIED ELSEWHERE

- A. Section 16510 - Interior Fixtures Equipped for Emergency Use
- B. Section 16520 - Exterior Fixtures Equipped for Emergency Use

1.03 SUBMITTALS

- A. Product Data: Include the following:
 - 1. Electrical characteristics.
 - 2. Furnished specialty components.
 - 3. Specified accessories.
 - 4. Dimensioned standard drawings indicating dimensions, weights, and attachments to other work.

1.04 OPERATION AND MAINTENANCE DATA

- A. Include routine maintenance, adjustment requirements, safety information, and troubleshooting guide. Contact names and information for parts and assistance shall also be provided.

1.05 COORDINATION

- A. Coordinate sizes and locations of supports required for emergency units.

1.06 FIELD CONDITIONS

- A. Handling and Storage: Handle and store emergency lighting units in accordance with manufacturer's published instructions. Examine units upon delivery for damage. Store units protected from weather.

1.07 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to furnish replacement components for units that demonstrate defects in workmanship or materials under normal use within warranty period specified.

1. Warranty Period: 12 months from date of substantial completion.

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide the sizes and types shown on the Drawings as outlined in the Fixture Schedule, complete with all necessary hangers, lamps, and accessories.
- B. System Description: Furnish emergency lighting units completely assembled with wiring and mounting devices, ready for installation at the locations indicated. Equip fixtures with lamps. Ensure emergency lighting units are suitable for operation on the ac supply circuit to which they are to be electrically connected.
- C. Performance Requirements: Provide emergency lighting units conforming to UL 924 and NFPA 101.

2.02 MANUFACTURED UNITS

A. Emergency Lighting Egress Units

- 1. Provide complete self-contained emergency lighting units with batteries, battery charger, one or more local or remote lamp heads with lamps, under-voltage relay, indicator lights, on/off switch, and test switch, in accordance with UL 924 for Type I (emergency light set), with non-refillable sealed nickel-cadmium battery, capable of providing 90 minutes of illumination.
- 2. Lampheads, Lamps, and Indicating Lights: Mount the lampheads on the top of the unit enclosure, or wall mount, except where otherwise indicated. Lampheads shall be mounted such that they are fully adjustable in the horizontal and vertical planes.
- 3. Where designated, emergency units, lampheads, lamps and related components shall be designated for installation within Class 1, Division 1, Group D locations.

2.03 EXIT UNITS - STANDARD

- A. Exit lights shall be two-piece construction, gray polycarbonate housing and white polycarbonate face, 120/277V AC input, long-life "LED" type

with RED lettering. Units shall be combination units equipped with two 3.6W LED heads.

- B. Exit units shall be wall mounted.
- C. Exit units with integral battery packs shall comply with UL924 and NFPA 101 and shall provide a minimum of 90 minutes illumination in the event of a power outage.
- D. Provide integral Ni-Cad battery packs with solid state charger, and self-diagnostics.
- E. Exit units shall be rated for use in wet locations.
- F. Unit shall be equipped with self-diagnostics and shall be rated for an operating temperature of 0°C to 50°C.
- G. Refer to Fixture Schedule for additional information.

2.04 EXIT UNITS – SELF-LUMINOUS

- A. Exit lights shall be of polycarbonate construction, non-electric, with a RED background color and WHITE lettering. Units shall utilize tritium gas as a source for illumination.
- B. Exit units shall be wall mounted.
- C. Exit units shall comply with UL924 and NFPA 101.
- D. Exit units shall be suitable for installation within Class 1, Division 1, Group D locations.
- E. Refer to Fixture Schedule for additional information.

PART 3 EXECUTION

3.01 GENERAL

- A. Permanently fix in place the emergency lighting unit and install wiring for each unit in accordance with NFPA 70. Use the same panel bus or branch circuit as that serving the normal lighting in the area for the branch circuit feeding the unit equipment, and connect ahead of area switches.
- B. Maintain remotely connected emergency lighting circuit wiring independent of all other wiring and equipment and do not enter the same conduit, cable, box, or cabinet with other wiring unless the fixture is

supplied from two sources.

3.02 FIXTURE MOUNTING

- A. Surface: Attach to appropriate work box or bracket.
- B. Mounting Heights: Install where shown on the Drawings, minimum of 7'-0" above floor in enclosed areas, 12'-0" in open process areas or as indicated on the Drawings.
- C. Location: Approximately where shown on the Drawings. Avoid serious obstructions to the light pattern. Do not mount in such a way that maintenance is made difficult. Avoid interference with equipment and piping.
- D. Exterior Wall Mounted Fixtures: Seal top and two side wall joints with silicon base 20 year life sealant. Do not seal bottom joint.

END OF SECTION

SECTION 16620

HEAT TRACE

PART 1 GENERAL

1.01 SCOPE

- A. Provide a heat tracing system for freeze protection or temperature maintenance of exterior above grade pipes and containers on systems indicated on the Drawings. Final layout, hardware, and connections shall be designed, furnished, and warranted by the supplier.

1.02 SUBMITTALS

- A. Submit system layout, wiring diagram and material information for approval in accordance with Section 01300 and Section 16010.
- B. Provide operation and maintenance data in accordance with Section 01730.

PART 2 PRODUCTS

2.01 HEATING CABLE

- A. Self-regulating type. Heating cables shall be capable of maintaining process temperatures up to 150°F (65°C) and of withstanding intermittent exposure to temperatures up to 185°F (85°C).
 - 1. Non-hazardous locations: Pentair Raychem Type 5BTv1, or equal.
 - 2. Class 1, Division 1, Group D locations: Pentair Raychem Type 5HBTV1, or equal.
- B. Service Voltage: 120 VAC

2.02 HEATING PADS

- A. Self-regulating type. Heating pads shall be capable of maintaining process temperatures up to 120°F (49°C) and of withstanding intermittent exposure to temperatures up to 366°F (186°C).
 - 1. Non-hazardous locations: Pentair Raychem Type RHS-L-1, or equal.
- B. Service Voltage: 120 VAC

2.03 HEAT TRACE ACCESSORIES

- A. Power Connection Kits: Provide equipment as recommended by heating cable manufacturer for interface of heating cable with power supply. Power connection kit configuration shall be selected based upon proposed installation location with appropriately rated equipment utilized within Class 1, Division 1, Group D locations.
- B. Lighted End Seals: Provide lighted end seals at heat trace cable termination.
 - 1. Non-hazardous locations: Pentair Raychem Model E-100-L, or equal.
 - 2. Class 1, Division 1, Group D locations: Pentair Raychem Model E-100-L, or equal. Provide connection kit accessories to interface end seal as required by location.
- C. Electric-Traced Label: Provide warning labels to indicate the presence of electrical heat-tracing under the insulation. Provide adequate labels to allow for a maximum spacing of 15 feet.
- D. Aluminum Tape: Provide tape as recommended by heating cable manufacturer to affix heating cable to pipe.

2.04 INSULATION

- A. 1/2" - 2" Pipe: AP/Armaflex or equal, pre-formed, 1" thick, closed-cell elastomeric thermal insulation. Thermal conductivity 0.245 Btu • in./h • ft² • °F.
- B. 2-1/2" and Larger Pipe: AP Armaflex/AP Armaflex FS Sheet and Roll, or equal, 1" thick, closed-cell elastomeric thermal insulation. Thermal conductivity 0.27 Btu • in./h • ft² • °F.
- C. Adhesive: Armstrong 520 or equal.
- D. Finish: Armstrong WB or equal water based latex enamel. White.

2.05 THERMOSTAT

- A. Controller:
 - 1. Non-hazardous locations: Ambient sensing, Raychem AMC-1A, or equal.
 - 2. Class 1, Division 1, Group D locations: Ambient sensing, Raychem AMC-1H, or equal.
- B. Enclosure: NEMA 4, 7, 9

1. Non-hazardous locations: NEMA-4X.
2. Class 1, Division 1, Group D locations: NEMA 4, 7, 9

C. Setpoint: 40°F.

D. Voltage: 120 VAC

2.06 JACKETS

- A. General: ASTM C 921, Type 1, except as otherwise indicated.
- B. Aluminum Jacket: ASTM B 209, 3003 Alloy, H-14 temper, roll stock ready for shop or field cutting and forming to required sizes.
 1. Finish and Thickness: Smooth finish, 0.010 inch thick.
 2. Moisture Barrier: 1-mil, heat-bonded polyethylene and kraft paper.
 3. Elbows: Preformed 45-degree and 90-degree, short- and long-radius elbows, same material, finish, and thickness as jacket.
 4. Provide stainless steel bands to secure jacketing and to support maintenance of the equipment.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install heat trace system in accordance with manufacturer's recommendations.
- B. Apply insulation in accordance with insulation and heat trace manufacturer's instructions. Cover all insulation butt joints with 3M #471 or equal tape or adhesive.
- C. Apply finish enamel to all exposed insulation surfaces in accordance with manufacturer's recommendations unless installation of aluminum jacketing is specified on the Drawings.
- D. Provide tape, caulking, conduit fittings and other necessary components to complete installation of heat trace equipment in accordance with manufacturer's recommendations.

3.02 ELECTRICAL INTERFACE

- A. Verify that the source voltage corresponds to the heating cable / heating pad rating printed on the cable jacket / heating pad and specified by the design.

- B. Verify that the over-current protection device protecting the heat trace circuit is classified as a ground fault protective device.

END OF SECTION

SECTION 16900

SUPERVISORY CONTROL & DATA ACQUISITION SYSTEM

PART 1 GENERAL

1.01 SCOPE

- A. The work to be accomplished under this section shall consist of furnishing the equipment necessary for a complete automatic control and monitoring system to function as specified herein and as shown on the drawings. The system integrator shall furnish a completely integrated all solid-state radio telemetry base Supervisory Control and Data Acquisition (SCADA) system. The complete system shall be designed, fabricated, programmed, tested, started up, and warranted by a single supplier to insure a single source of responsibility.
- B. Scope of Work: This section covers a radio SCADA system to include:
 - 1. Interface of proposed equipment at the WWTP as outlined within the Drawings and Specifications.
 - 2. Alarm dialer for remote communication of alarms.
- C. General/Electrical Contractor Shall Supply
 - 1. All equipment required in other sections of the specifications.
 - 2. All labor for installation of the RTU and radio equipment.
- D. System Integrator Shall Supply:
 - 1. Engineering submittal and shop drawings prior to installation.
 - 2. Operation and maintenance manuals, as detailed in this section.
 - 3. All start-up labor and services, as required for equipment specified in this section.
 - 4. Operator training as detailed in this section.
- E. Owner Shall Supply:
 - 1. Access and easements as needed for all sites.
 - 2. 120 VAC power at all sites.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: The system specified herein shall be the product of a manufacturer who can demonstrate at least ten (10) years of

satisfactory experience in furnishing and installing comparable radio based telemetry/control systems for water and wastewater installations.

- B. The manufacturer of this system shall maintain a 24-hour available inventory of all replaceable modules to assure the Owner of prompt maintenance service and a single source of responsibility. The manufacturer shall certify this to the Engineer in writing at the time of bidder pre-qualification.

C. Pre-Bid Approval:

1. The Base Bid approved systems integrator for this project is:
Micro-Comm, Inc. Local Contact:
15895 S. Plfumm Rd Hydro-Dynamics, Inc.
Olathe, KS 66066 (513) 899-9992
2. Other integrators desiring to bid this project as "alternate" integrators must seek pre-bid approval by providing a submittal ten (10) days prior to the bid date. Submissions that fail to include a complete submittal as detailed shall be deemed unresponsive. The Engineer and the Owner shall be the sole judge as to whether the alternate equipment is considered an approved equal. Approval of an alternate system by the Engineer will not relieve the alternate system of strict adherence to these specifications. The pre-bid submittal shall include the following:
 - a. An installation list with the names and phone numbers of both the Owner and Engineer for at least ten projects of similar size and complexity.
 - b. A "statement of compliance" detailing paragraph by paragraph the bidder's compliance to these specifications.
 - c. Block diagrams for the various sites in the proposed system showing the selected pieces of hardware equipment to be used.
 - d. Sample electrical drawings for typical sites proposed in this contract.
 - e. A product performance data sheet shall be included for each hardware component in the system (i.e. antennas, radios, coaxial cables & arrestors, programmable controllers, power supplies, time delays and relays, and the various sensors required) and each software component (programming & configuration software and operator display console software).
 - f. Radio path study for each radio path in the system. Bidders shall satisfy themselves that the necessary radio frequency(s) can be obtained. The radio path study provided by each bidder shall utilize either:
 - 1) Computer generated techniques utilizing a USGS 3 second terrain database to plot the path profiles for each radio path with elevation samples at not more than 200 foot increments.
 - 2) Actual field measurements to showing the necessary antenna heights, transmitter power, and antenna gains required to insure a 20db fade margin as detailed in these specifications. The

physical path analysis shall be made using temporary equipment installations and a radio communications analyzer to measure actual path margins. The bidder shall include in his bid, all the calculations used to extrapolate the measured data. The bidder is expected to obtain the necessary temporary FCC license for the study.

- g. Communications diagram for the entire system showing normal CTU-RTU communications paths and Peer-to-Peer back-up communications paths.

D. Approval Agencies: The control system and its components shall comply will all applicable requirements of the following:

- 1. Electrical Code Compliance (National & Local)
- 2. UL 508A
- 3. NEMA Compliance
- 4. IEEE Compliance
- 5. EIA Compliance
- 6. FCC Compliance

1.03 RELATED SECTIONS

- A. Section 16010 – General Electrical Provisions
- B. Section 16020 – Conduit Systems
- C. Section 16030 – Wire and Cable
- D. Section 16035 – Instrument Wire and Cable

1.04 SUBMITTALS

- A. Submit under provisions of Section 01300 and Section 16010.
- B. Product Data: Include list which indicates use, operating range, total range and location for manufactured components.
- C. Submit manufacturer's installation procedures under provisions of Section 01300.
- D. Complete submittal shall be provided to the engineer for approval prior to equipment fabrication. The submittal data shall include the following:
 - 1. Product Data - Provide product data sheets for each instrument and component supplied in the system. The data sheets shall show the component name as used on reference drawings, manufacturer's model

number or other product designator, input and output characteristics, scale or ranges selected, electrical or mechanical requirements, and materials compatibility.

2. Shop Drawings - Provide drawings for each panel showing the wiring diagrams for control circuits and interconnections of all components. The drawings shall include wiring diagrams for all remote devices connected to the panel.
3. Panel Layout Drawings - A front panel and sub-panel layout shall be included as part of each control panel drawing. Components shall be clearly labeled on the drawing.
4. Installation Drawings - Typical installation drawings applicable to each site in the system shall be included.
5. Operator Interface Software - The submittal shall include a generic but detailed technical description of the Operator's Interface Software as proposed for this system including:
 - a. Sample text screens and menus
 - b. Sample graphics screens
 - c. Sample report logs and printed graphs

1.05 MAINTENANCE INFORMATION

- A. Maintenance Data Manuals: Submit maintenance manuals and "as built" drawings on all items supplied with the system. The manuals and drawings are to be bound into one or more books as needed. In addition to "as built" engineering submittal data and drawings, the manual shall include trouble shooting guides and maintenance and calibration data for all adjustable items.

1.06 JOB CONDITIONS

- A. All instruments and equipment shall be designed to operate under the environmental conditions where they are to perform their service. The equipment shall be designed to handle lightning and transient voltages as normal environmental hazards. The environmental conditions are as follows:
 1. Outdoor - The equipment will be exposed to direct sunlight, dust, rain, snow, ambient temperatures from -20 to +120 degrees F, relative humidity of 10 to 100 percent, and other natural outdoor conditions. The installations shall be hardened to withstand normal vandalism.
 2. Indoor - The equipment will be capable of operating in ambient temperatures of +32 to +130 degrees F and relative humidity of 20 to 100 percent.

1.07 DELIVERY, STORAGE, & HANDLING

- A. All items shall be stored in a dry sheltered place, not exposed to the outside elements, until ready for installation. All items shall be handled with appropriate care to avoid damage during transport and installation.

1.08 SEQUENCING & SCHEDULING

- A. Coordination: The Systems Integrator shall coordinate with other electrical and mechanical work including wires/cables, raceways, electrical boxes and fittings, controls supplied by others, and existing controls, to properly interface installation and commissioning of the control system.
- B. Sequence: Sequence installation and start-up work with other trades to minimize downtime and to minimize the possibility of damage and soiling during the remainder of the construction period.

1.09 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Section 01700.

PART 2 PRODUCTS

2.01 ENCLOSURES

- A. Enclosures shall be NEMA 1 for indoor and NEMA 4X for outdoor locations. Enclosure shall be fabricated from a minimum of 14-gauge cold rolled steel with a baked enamel finish in the manufacturer's standard color. Units shall include a single gasket front door. Hinges, locking hasp and door clamping hardware shall be included.

2.02 INCOMING POWER REQUIREMENTS & UPS

- A. Controls shall operate from a source of 120 volts, 1 phase, 60 Hz. Each panel shall be accompanied with an uninterruptible power supply (UPS). The UPS shall condition the power as well as provide 500 VA of power during outages. A 6-amp control power circuit breaker shall be employed as both a method of equipment protection and as a means of power disconnection. The circuit breaker shall be a single pole, thermal, magnetic type with a 10,000 Amp Interrupt Current rating. The circuit breaker shall be UL listed.

2.03 POWER SUPPLIES

- A. All DC power supplies required for operation shall be provided. Units shall provide sufficient voltage regulation and ripple control to assure powered components can operate within their required tolerances.

2.04 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) – DATA COMMUNICATIONS AND SIGNAL WIRING

- A. The system manufacturer shall provide transient voltage and surge suppression for all PLC data communication devices whenever the communications cable is located outside the building in which the panel resides. This also applies to all outdoor panels with communications cables exiting the PLC panel enclosure. The TVSS unit shall be UL 497B listed. The TVSS unit shall have a maximum DC operating voltage of 9.6 VDC, a clamping voltage of 81V, and an 8 x 20 US surge current rating of 1000 amps.
- B. Transient voltage and surge suppression shall also be provided for 10-32 VDC instrumentation signal systems. The TVSS units shall be employed when the signal cable extends beyond the boundaries of the building in which the PLC panel is located. The TVSS unit shall be UL 497B listed. The TVSS unit shall have a maximum operating voltage of 32 VDC, a clamping voltage of 100V, and an 8 x 20 US surge current capability of 1000 amps.
- C. TVSS units shall be as manufactured by Leviton, Inc., of Little Neck, New York, Model 3803-485/DHP or equal for PLC communications and Model 3420-009/035 for 10-32 VDC signal wiring or equal.

2.05 NETWORK DATA LINE SURGE SUPPRESSORS

- A. Provide transient surge suppressors for all leased telephone line, and Ethernet connections that are included as a part of this system. Unit shall have connection capabilities for RJ45, 100 BASE-T, 10 BASE-T, Token Ring, and RS-422 connections. The unit shall have a nominal clamping voltage of 7.5 volts and a Peak Pulse Current rating of 750 amperes. Unit shall be as manufactured by Tripp Lite, Inc., Model DNET-1 or equal.

2.06 TELEPHONE LINE SURGE SUPPRESSORS

- A. Provide the following for all dial-up connected to data modems or automated alarm dialing equipment that are included as a part of this system. Unit shall have connection capabilities for RJ11 or RJ45. The unit shall have a nominal clamping voltage of 260 volts and a Peak Pulse Current rating of 1020 amperes. Unit(s) shall be as manufactured by Tripp Lite, Inc., Model DTEL2 or equal.

2.07 HIGH SPEED DATA RADIOS (900MHZ MAS & 900MHZ SPREAD SPECTRUM)

- A. General

1. Specific communications paths in the system may utilize a "high-speed data radio" to provide fast data update and control implementation. The radios shall operate in the 928-952MHz licensed frequency bands (or optionally in the unlicensed 900MHz Spread Spectrum Radio band). The radios shall provide half duplex or simplex operation as required by the control system.
2. The high-speed data radios shall have integral digital data modems that provide 9600bps data transmissions with a 10mS data turn-around time. Connection to the RTUs shall be via a standard DB-25F connector with a RS-232 interface. The radios shall be synthesized and fully field programmable and include a built-in time-out timer to disable the transmitter. Programmability shall include transmit and receive frequency, output power, time-out timer (1-255sec or off), RTS-CTS delay (1-255mS), PTT delay (0-31mS), and squelch tail eliminator. The units shall be tuned to FCC specifications for the specific frequency assigned.

B. Un-Licensed Spread Spectrum Data Radios

1. The un-licensed data radios shall have 1-watt of output power and integral digital data modems to insure a high level of quality and reliability. The radios shall be adjustable to .6 watts output power as may be required by the FCC for ERP (Effective Radiated Power) restrictions. The high-speed data radios shall have integral digital data modems that provide 9600bps to 2mbps data transmissions with a 10mS data turn-around time. Connection to the RTUs shall be via a standard DB-9F RS232 (and/or optional RJ45 Ethernet) interface. All connections to the radio shall be plug-in. The data radios shall have the following specifications:

Transmitter:

RF output power	1 watt (adjustable to .6watt)
Spurs & Harmonics	-65 dBc
Frequency stability	$\pm 0.00015\%$ (-30 to +60 degrees C)
Emission	12F2 (with 5kHz DEV max)

Receiver:

Bit Error Rates (BER)	1x10 ⁻⁶ at -110dbm @ 9600 baud or 1x10 ⁻⁶ at -99dbm @ 256bps for Ethernet Radios
IF Selectivity	-100 dB
Inter-modulation	-75 dB
Frequency stability	$\pm 0.00015\%$ (-30 to +60 degrees C)
Receive bandwidth	12kHz as required to match the transmitter

2. The data radios shall be Microwave Data Systems MDS Orbit or equal.

C. Antenna & Coaxial Cable

1. The radio antennas at all locations shall be a seven to nine element Yagi, constructed with 3/8" diameter solid aluminum rod elements and aluminum pipe element support with a type N coaxial connector. The antenna shall have a minimum 9.0db forward gain with a 20.0db front-to-back ratio. The antenna shall be wind rated for a 100-MPH wind speed. The antennas shall be MC-Yagi, Celwave PD688S, Celwave PD10108, or equal.
2. Directional antennas shall be cabled to the transmitter enclosure connection by a Amphenol 9913 low loss (less than 4.3db per 100ft @ 900MHz) coaxial cable with semi-solid polyethylene dielectric or heliax cable as needed to maintain the required 20db of operational pad. The coaxial cable shall have a combination braided copper and aluminum foil shield with coverage of 100% and a long life weather resistant polyvinyl chloride jacket. The antenna coaxial cable connection shall be a constant impedance weatherproof Type N connector, taped with a weather resistant electrical tape to insure a lifetime watertight assembly. The coaxial cable shall be Belden 9913 cable or heliax type cable as needed.
3. Omni-directional antennas used at data repeater sites shall be center-fed collinear antennas to insure consistent gain and impedance across the operating frequency band and provide a minimum of 7.5dBd gain. The antenna shall be constructed of copper alloy radiating elements encased in a weatherproof fiberglass low loss housing and permanently attached to a 6061-T6 aluminum support pipe. The Omni-directional antenna shall be a Celwave PD1109 or equal.

D. Antenna Lightning Protection

1. Coaxial connection to remote and central unit enclosures shall be by means of a type N coaxial type bulkhead lightning arrestor. The units shall be rated at 1 kilowatt with a minimum 500V and maximum 2000V-breakdown voltage. Coaxial lightning arrestors shall be a PD-395, r PolyPhaser IS-B50LU-CO, or equal.

E. Antenna Mounting Systems

1. Antennas shall be mounted at a height above ground that is consistent with FCC rules and regulations and provides adequate signal fade margin as described earlier. Antennas must be a minimum of 15 feet above ground and mounted as follows:
 - a. Above Ground Structures: The antenna shall be mounted on a 10' long X 1-1/2" diameter galvanized mast with top mounted weather-

head. The mast assembly shall be secured to the side of the building or equipment rack structure with Uni-strut clamps.

PART 3 EXECUTION

3.01 FCC LICENSING

- A. The system manufacturer/supplier shall be responsible for collecting all information, generating all paper work, and paying all fees required for modifying the license on behalf of the Owner.

3.02 EQUIPMENT EXAMINATION

- A. The control system shall be completely tested prior to shipment. The entire control system shall be "Burned In" at the factory for a period of at least 20 days. The component equipment shall be computer tested and temperature cycled at zero degrees and at fifty degrees centigrade.
- B. All local indicators, transmitters and converters shall be inspected that the correct scales have been supplied.
- C. Inspect area to assure the locations for the equipment to be installed are suitable for their application.

3.03 PREPARATION

- A. Contractor and System Integrator shall coordinate on installation of related components, verifying interface of equipment, scales, etc.

3.04 SYSTEM START-UP

- A. The system manufacturer shall supply "Factory" personnel for start-up service as needed to insure satisfactory operation. Subsequent trips to the job site to correct defects shall be made at no charge to the Owner during the warranty period.

3.05 TRAINING

- A. The manufacturer shall supply "Factory" personnel for start-up service as needed to insure satisfactory operation. The training shall be conducted include a minimum of two days of on-site training sessions. Subsequent trips to the job site to correct defects shall be made at no charge to the Owner during the warranty period.
- B. The initial training session shall be conducted during start-up as needed until the Owner and Engineer are satisfied that the operators are comfortable with

the operation and maintenance of the system. Training shall be done on site with the Owner's personnel.

3.06 SUBSTANTIAL COMPLETION

- A. The Engineer will recommend substantial completion to the Owner only after completion of the start-up and initial training phase of the project. The Engineer shall make an inspection of the system to determine the status of completion. Substantial completion will be awarded only when the system is providing usable service to the Owner. If the system is commissioned in phases, the Contractor may request substantial completion for the completed phases.

3.07 WARRANTY/SUPPORT PROGRAM

- A. The control system manufacturer shall supply a five (5) year parts and labor warranty and comprehensive support program for all items and software supplied under this section (except as noted below). Power surges and lightning damage shall be included as part of the warranty.
- B. The warranty shall begin from the time of "substantial completion" as issued by the Engineer and Owner. The manufacturer shall provide a 24-hour response to calls from the Owner. The manufacturer, at his discretion, may dispatch replacement parts to the Owner by next-day delivery service for field replacement by the Owner. Any damage to the control system caused by the actions of the Owner in attempting these field replacements shall be the sole responsibility of the system manufacturer. If, during the warranty period, satisfactory field repair cannot be attained by field replacement of parts by the Owner, the system manufacturer shall dispatch "factory" personnel to the job site to complete repairs at no cost to the Owner.
- C. The support program shall begin from the time of "substantial completion" as issued by the Engineer and Owner. The support program shall include free updating of all software as needed and providing free phone support from the integrator throughout the warranty period.

END OF SECTION

SECTION 16901

INSTRUMENTATION

PART 1 GENERAL

1.01 SCOPE

- A. Ultrasonic Level Sensors
- B. Float Switch Assemblies
- C. Loop Power Supply
- D. Transient Suppressor
- E. New Automatic Sampler
- F. Existing Instrumentation - Relocation of Existing Sampler(s)
- G. Combustible Gas Detectors
- H. Smoke Alarm
- I. Sump High Level Alarm

1.02 RELATED SECTIONS

- A. Refer to the following specifications for related requirements and equipment:
 - 1. Section 15270 – Flow Meters
 - 2. Section 16010 – General Electrical Provisions
 - 3. Section 16015 – Electrical Grounding
 - 4. Section 16020 – Conduit Systems
 - 5. Section 16030 – Conductors
 - 6. Section 16035 – Instrument Wire and Cable
 - 7. Section 16170 – Process Control Panels and Hardware
 - 8. Section 16180 – Equipment Wiring
 - 9. Section 16190 – Supporting Devices
 - 10. Section 16195 – Electrical Identification
 - 11. Section 16900 – Supervisory Control & Data Acquisition System

1.03 SUBMITTALS

- A. Submit product data under the provisions of Section 01300 and Section 16010.

- B. Product Data: Include list which indicates use, operating range, total range and location for manufactured components.
- C. Submit manufacturer's installation requirements under the provisions of Section 01300 and Section 16010.

1.04 PROJECT RECORD DOCUMENTS

- A. Submit documents under provisions of Section 01700.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instrumentation when areas are under construction, except from required rough-in, taps, supports and test plugs. Protect openings from construction debris.

PART 2 PRODUCTS

2.01 ULTRASONIC LEVEL SENSOR

- A. Provide ultrasonic level sensor(s) and related components to provide level control as designated in the Drawings. Ultrasonic level sensors and related monitors shall be supplied from the same manufacturer.
- B. Provide and install an ultrasonic sensor, meter, and related components that will provide measurement and readout for the fluid level at the designated location.
- C. The ultrasonic sensor shall be a Eastech Flow Controls Model FB-5 or equal. The sensor shall be constructed of glass filled polyester and shall have a maximum range of 25 ft. and a 10 degree beam angle. The transducer shall be specifically selected for the application designated for each location. Selection of the transducer model shall also factor the configuration of the channel, tank, etc. where the unit is to be installed.
- D. Mounting frame will be of corrosion resistant materials and be capable of withstanding the force of the flow through the structure while being submerged without changing the location of the transducer.
- E. The level monitor (meter) shall be a Eastech Flow Controls Vantage Model 2210 or equal. The unit shall be a dual channel ultrasonic level meter that can be programmed for level and/or flow applications. Applicable flow applications shall include flumes, weirs or free flow equations.

- F. The level monitor shall be equipped with a backlit LCD display, front panel programming keypad, a 4-20 mA output, RS232 serial port, RS-485 serial port, up to 5 programmable relays and an internal data logger. The unit shall be equipped for readout in engineering units.
- G. The monitor shall be housed within a NEMA 4x, IP 66 rated enclosure. Where designated, the unit shall be rated for use within Class 1, Division 1, Group D locations.

2.02 FLOAT SWITCH ASSEMBLY

- A. Provide float switches as indicated. Float switches shall be mercury switches hermetically sealed within the float suspended with 3-conductor immersion-rated control cable with cast iron weight affixed to cable above the float. Switch contacts shall be used in pilot-control circuits and be rated 12 amps at 115 or 230 volt AC.
- B. Assemble float switches of type and quantity based on application and location. Where designated, floats shall operate as back-up controls when primary level control system is not available.
- C. Float switch cable shall be terminated in weatherproof fiberglass junction boxes. Splicing of cables will not be accepted.
- D. Provide 1-inch diameter PVC float stem to facilitate installation of float assembly. Provide ABS float collars to secure floats to float stem.
- E. Refer to Float Schedule for quantity and operation sequence of floats at designated locations.

2.03 TRANSIENT SUPPRESSORS

- A. Provide transient suppressors for 4 - 20 ma control loops at each field device and analog input termination.
 - 1. Field Device.
 - a. Joslyn, Model 1669-02, 1669-06
 - b. EDCO SS64-036-1, SS64-036-2
 - c. Or equal.
 - 2. Panel Terminal.
 - a. Joslyn, Model 1800-28
 - b. EDCO PC642C-030 with PCB1B
 - c. Or equal.
- B. Provide transient surge suppressors for 120 / 240 volt ac powered devices

1. Joslyn Model 1260-11
2. EDCO FAS-120AC
3. Or equal.

2.04 LOOP POWER SUPPLY

- A. Provide a 24 volt DC regulated power supply with an output rated for a minimum of 250 ma. Input power to be 120 VAC.
- B. Provide line and output fuse protection of power supply.
- C. Mount power supply in protective enclosure or incorporate as a part of a local control panel for related equipment. Where loop power supply is installed in a separate enclosure, enclosure shall be NEMA 12 (indoor) or NEMA 4X (outdoor). Enclosure shall be labeled in accordance with Section 16195.

2.05 ALL WEATHER SAMPLER

- A. Provide an all-weather refrigerated sampler suitable for automatically collecting waste water samples based upon the operator designated sample timing. Unit shall be suitable for exterior installation and ambient temperatures -40 to 50 °C (-40 to 122 °F); with controller compartment heater and AC battery backup. Included sample container shall be a single polyethylene bottle, 10 L (2.5 gal). Unit shall be equipped for flow pacing. Sampler shall be Hach Model AS950 or equal.

2.06 RELOCATION OF EXISTING SAMPLER(S)

- A. Where noted, relocate the existing sampler(s) to the new location(s) designated on the Drawings. Coordinate with the Owner prior to relocating the sampler(s) to assure that plant operations are not disrupted.
- B. Interface sampler(s) with localized receptacle(s) designated for that purpose.

2.07 COMBUSTIBLE GAS DETECTOR

- A. Provide a standalone transmitter to monitor the level of combustible gas present at the location specified on the Drawings.
- B. The transmitter shall be RKI Instruments Model M2A or equal.
- C. The transmitter shall be suitable for installation in Class 1, Division 1, Group D locations.
- D. Interface detector with loop power supply and SCADA system.

2.08 SMOKE ALARM

- A. Provide a single station smoke alarm to monitor environmental conditions at the location designated on the Drawings. The sensor shall be in full compliance with NFPA 72 and UL standards.
- B. The system smoke detector shall be standalone, photoelectric or ionization type suitable for area installed. Detector shall be 120 VAC supplied with battery backup. Detector shall provide an audible alarm and a dry contact, 0.5 amp at 120 VAC for remote monitoring by the SCADA System.
- C. Detector shall be Gentext-9120TF, Sensaphone-FGD-0049-B, or equal.
- D. Interface detector with power supply and SCADA system.

2.09 SUMP HIGH LEVEL ALARM

- A. Provide a standalone sump water level alarm to monitor high water level at the location specified on the Drawings.
- B. The alarm shall be Liberty Pumps Model ALM-P1 Alarm with Probe Sensor or equal.
- C. The water level sensor shall be a probe style sensor. Use of a mechanical float switch to signal water level is not acceptable.
- D. The unit shall be suitable for installation at interior locations and shall operate via 115 VAC. The unit shall be equipped with a battery back-up.
- E. Alarm signals incorporated into the unit shall include an audio alarm signal, a visual alarm signal and auxiliary contacts for interface with the SCADA system.
- F. Interface level alarm with localized receptacle designated for that purpose and with SCADA system.

PART 3 EXECUTION

3.01 EXAMINATION

- A. All local indicators, transmitters and converters shall be inspected that the correct scales have been supplied.
- B. Inspect area to assure the locations for the equipment to be installed are suitable for their application.

3.02 PREPARATION

- A. Coordinate with the General Contractor for installation of related components.
- B. Contractor shall perform all chasing, channeling, drilling and necessary patching. Repair any damage to the building or equipment made during installation. Replace damaged equipment if in the Engineer's judgment, the repair would not be satisfactory. No work shall be covered or hidden from view until it has been inspected and approved by the Engineer. Any workmanship or materials not meeting the requirements of the Specifications or Drawings shall be immediately replaced by the Contractor without cost to the Owner and to the satisfaction of the Engineer.

3.03 INSTALLATION

- A. Mount local indicators, transmitters, and converters a maximum of six feet above floor or grade level in a readily accessible location.
- B. Install and calibrate all primary elements, field devices, transmitters, and other instruments per manufacturer recommendations and as indicated on the Drawings. Set pressure switches, limit switches, etc. for proper operation.
- C. Shielded cables shall be grounded at one point only. Install surge suppressors at a minimum of one location within each control loop.
- D. Ultrasonic Transducers: Transducer(s) shall be installed so that the beam angle covers the flow area without interference. Provide and secure the cable to the adjacent structure and to transition to external wiring.
- E. Float Switches: Float switches shall be installed in a manner that the float switch hangs free and is not in contact with a wall or any other device. The cable shall be securely attached to a support in such a manner that will prevent the float cables from becoming entangled. The cable support shall also be located to permit easy access to the cables for adjustment and replacement.
- F. New (Replacement) Automatic Sampler: Coordinate with Owner for installation of new automatic sampler(s). Provide electric service for sampler(s) at new location(s) in accordance with the Drawings. Coordinate with Owner to complete calibration of unit(s) and positioning of sampling points. Complete installation of new sampler prior to removal from service of existing sampler that is to be replaced.

- G. Existing Automatic Sampler: Coordinate with Owner for relocation of existing sampler(s) following start-up of new equipment and in advance of demolition of existing components. Provide electric service for sampler(s) at new location(s) in accordance with the Drawings. Coordinate with Owner to complete calibration of unit(s) at new location and positioning of sampling points.
- H. Combustible Gas Detector: Install detector at designated location. Provide calibration and start-up testing as outlined within manufacturer's installation instructions. Interface detector with SCADA system and verify operation. Provide training to Owner personnel on operation, calibration and servicing of detector.
- I. Smoke Alarm: Install detector at designated location. Provide calibration and start-up testing as outlined within manufacturer's installation instructions. Interface detector with SCADA system and verify operation. Provide training to Owner personnel on operation, calibration and servicing of detector.
- J. Sump High Level Alarm: Install detector to monitor water level in existing sump. Installation shall be made in such a manner to avoid interference with existing sump pump control floats and with removal of existing pumps from sump. Provide calibration and start-up testing as outlined within manufacturer's installation instructions. Interface detector with SCADA system and verify operation. Provide training to Owner personnel on operation, calibration and servicing of detector.

3.04 QUALITY ASSURANCE

- A. Performance Demonstrations: The Contractor shall perform the demonstrations listed below in the presence of the Engineer. These demonstrations are required to show the satisfactory functioning of all equipment and wiring. All calibration instruments shall have a minimum of five times greater accuracy than the unit being calibrated. All calibration instruments shall have their accuracy traceable to the National Bureau of Standards.
 - 1. A written record shall be provided for all performance demonstrations. The record shall include the date; time; technician's name; manufacturer, model number, serial number, and date of last calibration of the calibration unit; manufacturer, model number, and serial number of the instrument being calibrated; and any other necessary data for the instrument being calibrated. The form shall be initiated by the Engineer indicating that the demonstration was acceptable. The original records shall be included with the system documentation. Engineer will furnish

sample copy of the form to be used.

2. Demonstrate that all of the devices in each analog loop are calibrated within specified accuracy over their full range as indicated on the Drawings.
3. Demonstrate proper functioning of each control circuit. This shall include interlocks, sequencing, alarms, etc. as required by each circuit.
4. Demonstrate that all alarm points are functioning. Demonstrate that all analog alarm points are calibrated as indicated on Drawings or as determined in the field.
5. Demonstrate the proper functioning of all special items as specified or as indicated on the Drawings. These items may include but are not limited to the following: Telephone dialers, alarm horn silencing, meters, level sensors, etc.
6. Repair or replace any equipment or materials which fail during the demonstration and repeat the demonstration until satisfactory performance is obtained.

3.05 SPARE PARTS

A. Provide spare materials as listed:

1. Other: One year's supply of any consumable product, i.e. special lubricants, buffer solutions and spare parts for each instrument as recommended by manufacturer.
2. Float Switch: Provide two spare float switches.

3.06 FLOAT SCHEDULE

A. Provide floats in accordance with the following schedule. Elevations required for the installation of the floats shall be as shown on the Drawings or shall be coordinated with the Engineer at the time of installation. Contractor shall adjust float positions as needed during start-up of equipment to facilitate operation.

<u>Location</u>	<u>Float Quantity in Assembly</u>	<u>Operational Description (listed from lowest to highest)</u>
Influent Wet Well (Back-up)	5	1) Pump off
		2) Lead pump (7.5 HP) on
		3) Lag pump (7.5 HP) on / Pump #3 (15 HP) off
		4) Pump #3 (15 HP) on / Lead pump (7.5 HP) off
		5) High level alarm
RAS Pump Station	4	1) Pump off
		2) Lead pump on
		3) Lag pump on
		4) High level alarm

River Pump Station	4	1) Pump off
		2) Lead pump on
		3) Lag pump on
		4) High level alarm
Sludge Transfer Well	2	1) Pump off
		2) Pump on

END OF SECTION