Key West, FL
DENNIS STREET STORMWATER PUMP STATION
Project No. 193108
ITB NO. 19-015
Addendum No. 2
April 22, 2019

A. **SCOPE.** This Addendum No. 2 consists of pages AD2-1 through AD2-2. The Addendum covers the following questions from bidders and additions / changes to the specifications for this project, the updated specifications can be found attached to this document.

B. **QUESTIONS FROM BIDDERS**

1. The drawings show a water tight Junction Box in the Wet Well, will this be a Termination Box or simply a pull thru J box? Water Tight Termination Box with Terminal strips would eliminate the close to 100ft of large submersible power cables and Float cables. If this is a Termination box, will it be designed for both the Float cables and Motor Terminations? If so a Water Proof box will need to be sized properly.

    a. It is a pull thru junction box. It is understood that the gas detector manufacturer cable will need to be 100+ feet, which is longer than typical. Contractor should order required long cable from manufacturer. Aim is to avoid terminations due to possibility of corrosion in valve vault.

2. The External Geni Receptacle does not show a specified manufacture or part#?

    a. Specification 16050 was updated as shown in C-3 to include the generator receptacle information.

3. Hatch Covers Specifications 2.3 Design Requirements indicate that Fall protection grating panels shall be provided on doors and as indicated on the drawings. Hatch protection not shown on the drawings which isn't a problem, just want to clarify that all 5 hatches are required to have fall protection grating? Even the small 3'X3' Hatch.

    a. Fall protection has been determined to be unneccesary for all hatches. The appropriate specification section (08350) has been updated accordingly.

4. The pumps were not specified with the WILO CERAM Coating for the extreme corrosion protection, this coating was used for the George Street Pump station. No mention in the specifications about having to supply Zinc anodes to the pumps for Galvanic corrosion?

    a. For corrosion protection, specification 11150 was updated as shown in C-2 to include this protection as an option. Defer to pump manufacturer for specific corrosion protection.

    b. Any dissimilar materials should be isolated according to the specifications, Section 09940 – 3.1B. Specific issues will be addressed on a case by case basis.

C. SPECIFICATIONS.

1. Section 08350 – FLOOR ACCESS DOORS AND HATCHES

    a. Page 3, Paragraph 1, Design Requirements. DELETE "Fall protection grating panels shall be provided on doors and as indicated on the Drawings. The panels shall be aluminum or fiberglass grating panels designed to support a 300 psf loading. Panels shall be hinged along one edge and provided with a positive latch to maintain unit in an upright position. Provision for locking the panel in place shall be provided. All hardware shall be of non-corroding material."

2. Section 11150 – SUBMERSIBLE PUMPS

    a. Page 6, Materials Table, Epoxy Coating. ADD "or approved equal." after 'Carboline "Carboguard 891" or Tnemec "Series N140 Pota-Pox Plus"'for Primer & Finish Coat.

3. Section 16050 – ELECTRICAL

    a. Page 13. ADD Paragraph 2-25 "PORTABLE GENERATOR RECEPTACLE. 200A load breaking Portable generator receptacle with angle adapter and junction box. Russell Stoll MAX GARD series or approved equal. Connection shall be rated for 480, 3 phase, 3 wire plus ground. The receptacle shall be rated for 200A continuous current. Contractor shall coordinate generator receptacle pin configuration with Owner's generator plug.

Section 08305

FLOOR ACCESS DOORS AND HATCHES

PART 1 - GENERAL

1-1. SCOPE. This section covers the fabrication and installation of cast-in-place, off-street, floor access doors and hatches. Manhole frames and covers are specified in the Sewer Manholes section.

Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

Equipment shall be furnished complete with all components and accessories required for proper operation, and any additional materials or construction required by the manufacturer's design.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete assembly and installation drawings, together with detailed specifications, capacities, and data covering material used, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section.

Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-4. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1-5. WARRANTY. The manufacturer shall guarantee against defects in material or workmanship for a warranty period of not less than 5 years.

PART 2 - PRODUCTS

2-1. GENERAL. Access doors and hatches shall be fabricated in conformity with dimensions, arrangements, sizes, and weights or thicknesses specified herein and as indicated on the Drawings.

All members and parts shall be free of warps, local deformations, and unauthorized bends. Holes and other provisions for field connections shall be accurately located and shop checked so that proper fit will result when the units are assembled in the field. All field connection materials shall be furnished.

2-2. ACCEPTABLE MANUFACTURERS. Access doors and hatches shall be as manufactured by Halliday Products, Bilco Company, or USF Fabrications, Inc.

2-3. DESIGN REQUIREMENTS. Door leaves shall be 1/4 inch minimum thickness plate material with as indicated on the Drawings. Leaves in hatches not subject to vehicular loading shall be designed to withstand a minimum live load as indicated on the Drawings, with a maximum deflection of 1/150th of the span. Leaves shall pivot so that the cover does not protrude above the channel frame.

Door and hatch frames shall be provided with anchorage devices into the concrete slab. Where required for drainage, channel frames shall be 1/4 inch thick with a cross sectional area large enough to allow adequate water drainage. A 1-1/2 inch drainage coupling shall be located in the channel frame. The frame shall be designed to empty through the coupling. Frames shall have a neoprene door cushion unless a specific door model without a cushion is specified.

Hatches shall be supplied with lifting operators, lift assist springs, and hold-open devices. All doors, except fire rated doors, shall automatically lock in the vertical position by means of a hold-open arm with release handle. A snap lock with a gasketed cover plug and removable turn handle shall be provided. The operators shall provide for smooth, easy and controlled door operation throughout the entire arc of opening and closing. Operation shall not be affected by temperature.

~~*Fall protection grating panels shall be provided on doors and as indicated on the Drawings. The panels shall be aluminum or fiberglass grating panels designed to support a 300 psf loading. Panels shall be hinged along one edge and provided with a positive latch to maintain unit in an upright position. Provision for locking the panel in place shall be provided. All hardware shall be of non-corroding material.*~~

2-4. MATERIALS. Floor access doors and hatches are indicated on the Drawings. Unless otherwise specified, materials, appurtenances, and finishes shall be the manufacturer's standard for each type of door and hatch indicated on the Drawings. Doors and hatches shall be odor resistant and/or fire rated only if specifically indicated on the Drawings.

If floor access doors and hatches are shown on the Drawings but not identified by manufacturer's name and product number, Contractor shall request clarification from Engineer prior to ordering and shipping the equipment. For purposes of bidding the work, unidentified floor access doors and hatches shall be assumed to be galvanized steel with a drained channel frame, suitable for direct H-20 traffic loading with 30% impact factor.

2-5. FINISHES. Aluminum access doors and hatches shall be given a mill finish.

All aluminum surfaces in contact with concrete or mortar shall be given a heavy coat of epoxy enamel unless specified otherwise.

Steel doors shall be prime painted with manufacturer's standard primer or shall be hot-dip galvanized as indicated on the Drawings.

PART 3 - EXECUTION

3-1. INSTALLATION. Materials shall be erected and installed in conformity with the dimensions and arrangements specified or indicated on the Drawings and as recommended by the manufacturer. Product finishes damaged during erection shall be repaired as recommended by the manufacturer. Hatch frames with drainage couplings shall be connected to the appropriate drainage system.

End of Section

Section 11150

SUBMERSIBLE PUMPS

PART 1 - GENERAL

1-1. SCOPE. This section covers furnishing guiderail mounted, single-stage, submersible, non-clog, end suction centrifugal pumping units and controls as indicated herein or on the Drawings.

Pump application.	Stormwater Pumping
Number of pumps.	2
Pump tag numbers.	P-010
	P-020
Pump location.	Dennis St. Pump Station Wetwell

Each pumping unit shall be complete with a close-coupled, submersible electric motor, and all other appurtenances specified, or otherwise required for proper operation.

Each pumping unit, including motor and all integral controls, shall be rated and labelled for use in a Non-Hazardous Class 1, Division 1, Group D Class 1, Division 2, Group D area as defined by the National Electric Code.

1-2. GENERAL. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1-2.02. Seismic Design Requirements. Seismic design requirement for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Tagging. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service.

Tag numbers shall be clearly marked on all shipping labels and on the outside of all containers.

1-2.04. Power Supply. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase.

1-2.05. Identification. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1-3. SUBMITTALS.

1-3.01. Drawings and Data. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Pumps
- Name of manufacturer.
- Type and model.
- Tag number.
- Pump designation.
- Pump location.
- Rotative speed.
- Size of suction nozzle.
- Size of discharge nozzle.
- Net weight of pump and motor only.
- Net weight with pedestal, when specified.
- Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power.
- Data on shop painting.

Motors
- Name of manufacturer.
- Type and model.
- Type of bearings and method of lubrication.
- Rated size of motor, hp [kW], and service factor.
- Insulation class and temperature rise.
- Full load rotative speed.
- Efficiency at full load and rated pump condition.
- Full load current.
- Locked rotor current.

Moisture Detection System
- Name of manufacturer.
- Type and model.
- Enclosure rating and layout if an enclosure is specified.

Electrical schematics and wiring diagram.
Published descriptive data on each item of equipment and all accessories, indicating all specific characteristics and options.

Control Components

Type and manufacturer.
Model.
Enclosure rating.
Published descriptive data on all components, indicating all specific characteristics and options.
Where liquid level sensors are provided, provide mounting details.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-3.02. Operation and Maintenance Data and Manuals. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1-4. QUALITY ASSURANCE.

1-4.01. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including top of motor, shall not exceed the maximum velocity as indicated in Figure 11.6.9.4 of the governing standard.

At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1-5. SPARE PARTS. One Basic Repair Kit shall be provided as Spare parts.

Spare parts shall be suitably packaged with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2-1. ACCEPTABLE PRODUCTS. Equipment furnished under this section shall be manufactured by Wilo without exception.

2-2. SERVICE CONDITIONS.

The equipment provided under this section shall be suitable for the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section	
Maximum liquid temperature.	85	°F
Pumps start and stop against a closed valve.	No	
Site elevation.	See Meteorological and Seismic Design Criteria section	

All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at the elevation indicated.

2-3. PERFORMANCE AND DESIGN REQUIREMENTS. Pumping units shall be designed for the performance and design requirements as follows:

Pump tag numbers.	P-010	
	P-020	
Rated head.	30	ft
Capacity at rated head.	4930	gpm
Operating head range for full speed continuous operation.	20 to 30	ft
Maximum nominal pump speed.	1200	rpm
Maximum power required at pump input shaft at any point from minimum operating head to shutoff head.	50	bhp
Efficiency at rated head, wire to water.	75	%
Wetwell depth (guide-rail mounted).	13.5	ft
Minimum liquid depth in wetwell (guide-rail and skid mounted)	5	ft

Pump tag numbers.	P-010	
	P-020	
Pump designed for reverse rotation at rated head.	No	
Minimum NSPHA at rated head.	40.6	ft
Maximum vibration velocity.	HIS	
Minimum pump discharge nozzle/elbow size.	12	in
Minimum test sphere diameter.	3	in
Maximum suction pressure	4	psig

All specified conditions shall be at rated speed unless otherwise indicated.

Overall (wire-to-water) efficiency for constant speed pumps shall include losses in the pump and motor.

The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.

Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.01 inch or 1 mil per inch of casing wearing ring diameter, whichever is greater.

Pumping units shall be designed so that maximum reverse rotation due to reverse flow at rated head will not cause damage to any component. Pump supplier shall coordinate this provision with the motor supplier.

2-4. MATERIALS.

Stator Housing, Oil Chamber Housing, Impeller Casing, and Impeller	Cast iron, ASTM A48.
Casing Wearing Ring	Martensitic stainless steel, Brinell 300+.
Bottom Wearing Plate	Cast iron, ASTM A48 with spiral grooves.

Shaft	Alloy steel, hard chrome plated; or martensitic stainless steel, AISI Type 416 or 420.
Mechanical Seals	2 tandem single type, oil lubricated with silicon or tungsten carbide seal rings at all points, except the upper rotating seal, which shall be carbon.
Discharge Base	Cast iron or fabricated steel.
Guiderails	Stainless steel pipe, ASTM A312, Schedule 40S.
Upper guiderail bracket, cable hooks, and chain hooks	AISI Type 304 stainless steel.
Pedestal Base	Cast iron or fabricated steel.
Epoxy Coating	
Primer & Finish Coat	Carboline "Carboguard 891" or Tnemec "Series N140 Pota-Pox Plus" **or approved equal.**

2-5. PUMP CONSTRUCTION.

2-5.01. Impeller Casing. The impeller casing shall have well-rounded water passages and smooth interior surfaces free from cracks, porosity, blowholes, or other irregularities. The discharge nozzle shall be flanged and sufficiently rigid to support the pumping unit under all operating conditions.

2-5.02. Impeller. The impeller shall be a semi-open one-piece casting with not more than two nonclog passages. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity. The impeller shall be dynamically balanced and securely locked to the shaft by means of a key and self-locking bolt or nut.

2-5.03. Wearing Rings. Renewable wearing rings shall be provided in the casing and on the impeller.

For pumping units less than 100 hp a renewable wearing ring or an axially adjustable wearing plate shall be provided in the casing. Casing wearing ring shall be securely fastened to the impeller casing front cover to provide either an axial or radial running clearance. Axially adjustable wearing plate shall be arranged to permit adjustment of the axial running clearance between the

impeller and plate. The wearing plate shall have an outward spiralling groove designed to force stringy solids outward and away from the impeller.

2-5.04. Oil Chamber Housing. The oil chamber shall contain a drain plug and a vent plug. Food grade oil shall be used.

2-5.05. Mechanical Seals. Each pump shall be provided with two mechanical rotating shaft seals arranged in tandem and running in an oil chamber. Each interface shall be held in contact by an independent spring system designed to withstand maximum suction submergence. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.

Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication and shall not be damaged if the pumps are run unsubmerged for extended periods while pumping under load.

2-5.06. Sealing of Mating Surfaces. All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is needed. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.

2-5.07. Guiderail Mounted Base. A discharge base and discharge elbow shall be furnished by the pump manufacturer. The base shall be sufficiently rigid to firmly support the guiderails, discharge piping, and pumping unit under all operating conditions. The base shall be provided with one or more integral support legs or pads suitable for bolting to the floor of the wetwell. The face of the discharge elbow inlet flange shall be perpendicular to the floor and shall make contact with the face of the pump discharge nozzle flange. The diameter and drilling of the elbow outlet flange shall conform to ANSI B16.1, Class 125.

The pump and motor assembly shall be automatically connected to and supported by the discharge base and guiderails so that the unit can be removed from the wetwell and replaced without the need for operating personnel to enter the wetwell.

2-5.07.01. Sliding Bracket. Each guiderail mounted pumping unit shall be provided with an integral, self-aligning guiderail sliding bracket. The bracket shall

be designed to obtain a wedging action between flange faces as final alignment of the pump occurs in the connected position. The bracket shall maintain proper contact and a suitably sealed connection between flange faces under all operating conditions. The sliding bracket shall be nonsparking where the pump is installed in a hazardous area.

2-5.07.02. Guiderails. Each guide rail mounted pumping unit shall be equipped with one or more guiderails. Guiderails shall be sized to fit the discharge base and the sliding bracket and shall extend upwards from the discharge base to the location indicated on the Drawings. An upper guiderail bracket shall be provided at the pump access opening.

2-5.07.03. Lifting Chain. Each guide rail mounted pumping unit shall be provided with a chain suitable for removing and installing. The chain shall be stainless steel, galvanized, or plastic coated. Lifting chains shall have a tested yield point of at least 7 times the working load and shall be provided with durable permanent identification tags indicating the load rating. A suitable chain hook shall be provided at the top of the wetwell.

2-5.08. Pedestal Mounted Base. Not used.

2-5.09. Skid Mounted Base. Not used.

2-5.10. Access Hatch Cover. Not used.

2-5.11. Shop Painting. All iron and steel parts which will be in contact with pumped liquid or submerged after installation, including the inside of the casing and the discharge elbow, shall be shop cleaned in accordance with the coating manufacturer's recommendations. The exterior of the pump shall be painted with the epoxy coating system specified. The coating shall have a dry film thickness of at least 10 mils and shall consist of a prime (first) coat and one or more finish coats. At least 1 quart of the finish coat material shall be furnished with each pump for field touch-up.

All iron and steel parts inside the pump, including the surfaces of cast iron impellers, shall be painted with a suitable rust protective coating to protect the impeller during shipment, storage, and installation.

The shop painting of other surfaces shall be in accordance with the shop painting requirements in the General Equipment Stipulations.

For potable water applications, all coatings shall be NSF approved.

2-5.12. Hoist Assembly. Not used.

2-6. ELECTRIC MOTORS. Each pump shall be driven by an air-filled, totally submersible electric motor provided by the pump manufacturer. Motor nameplate rating shall exceed the maximum power required by the pump in the operating head range. Each motor shall be rated for the power supply provided to the pump, and shall have a service factor of 1.15. The stator housing shall be an air-filled, watertight casing. A cooling jacket shall encase the motor housing for each pump where needed to maintain adequate cooling. The cooling jacket shall require no external source of cooling water. Motor insulation shall be moisture resistant, Class H, 155°C. Each motor shall be NEMA Design B for continuous duty at 40°C ambient temperature, and designed for at least 10 starts per hour.

The motor bearings shall be antifriction, permanently lubricated type. The lower bearing shall be fixed to carry the pump thrust and the upper bearing free to move axially. The bearings shall have a calculated ABMA L_{10} Life Rating of 40,000 hours when operating at maximum operating head. Maximum shaft runout at the mechanical seals shall not exceed 2 mils at any point in the operating head range.

Each motor installed in a wetpit shall be capable of continuous operation in air (unsubmerged) for at least 24 hours under pump full load conditions, without exceeding the temperature rise limits for the motor insulation system.

Each pump shall be equipped with one or more multiconductor cable assemblies for power and control. Each multiconductor assembly containing power cables shall be provided with a separate grounding conductor. Each cable assembly shall bear a permanently embossed code or legend indicating the cable is suitable for submerged use. Cable sizing shall conform to NEC requirements.

All cables for wetwell mounted pumps shall be of sufficient length to terminate in a junction box outside the wetwell as indicated on the Drawings, with 10 feet of slack which will be coiled on a cable hook at the top of the wetwell. Each cable shall be supported by AISI Series 300 corrosion-resistant stainless steel Kellems or woven grips to prevent damage to the cable insulation. Mounting of cable supports in the wetwell shall be coordinated by Contractor to prevent damage to the cable.

The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing.

2-6.01. Adjustable Frequency Drives. Not used.

2-7. CONTROLS.

2-7.01. Liquid Level Sensors. Refer to Pressure and Level Instruments section for Liquid Level Sensons.

2-7.02. Pump Controls. Each motor shall be protected by one motor temperature switch embedded in each phase winding. Each switch shall be designed to operate at 140°C (± 5°C). Each switch shall be normally closed automatic reset type rated 5 amps at 120 volts ac. The switches shall be wired in series with end leads wired to terminals within the motor housing.

Each motor housing shall be provided with a moisture detection system complete with all sensors, control power transformers, intrinsically safe control modules, and relays. The moisture detection system shall be rated for a 12 volt dc supply. The moisture detection system shall provide two normally closed dry output contacts rated 5 amps at 120 volts ac. The contacts shall close when moisture is detected in the motor housing. Moisture detection sensors shall be furnished in the motor housing by the pump supplier. All moisture detection system components shall be furnished by the pump supplier.

2-8. SHOP TESTS.
Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be per Table 11.6.5.4 Grade 1U, with no minus tolerance or margin allowed.

Wire-to-water efficiency shall be based on certified efficiency data of the variable frequency drive, and the isolation transformer if provided with the drive. Certified efficiency data shall be included in the report.

Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, bhp [brake kW], pump efficiency, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements. All test points shall be clearly shown.

PART 3 - EXECUTION

3-1. INSTALLATION. Each pumping unit shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.

The equipment base for dry pit type pumping units shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, connections to pumping equipment shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

Control cables shall be supported to prevent tension and damage. Mounting of cable supports in wetwells shall be coordinated by the pump supplier. Liquid level sensors shall operate freely and shall be adjusted to the levels indicated in the respective pump schedules, or in the electrical schematics or P&ID's. Each system of sensors shall be installed complete with all required mounting brackets, weights, galvanized steel mounting pipes and accessories, control panel transformers, auxiliary relays, cables, and junction boxes.

3-2. FIELD QUALITY CONTROL.

3-2.01. Installation Check. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Section 01650, Startup Requirements, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

All costs for these services shall be included in the contract price.

3-2.02. Installation Supervision. Installation supervision by the manufacturer is not required.

End of Section

Section 16050

ELECTRICAL

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.

This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

This section covers installation of equipment furnished by Owner.

1-2. GENERAL. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1-2.01. General Equipment Stipulations. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

1-2.02. Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

1-2.03. Coordination. Electrical work shall conform to the construction schedule and the progress of other trades.

1-2.04. Anchor Bolts and Expansion Anchors. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

1-2.05. Drawings. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1-3. CODES AND PERMITS. All work shall be performed, and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

Equipment covered by this section shall be listed by UL, or by a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1-4. SEISMIC DESIGN REQUIREMENT.

1-4.01. Seismic Design Requirements. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-5. IDENTIFICATION.

1-5.01. Conduit. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gauge stainless steel, with 1/2 inch stamped letters and numbers as indicated on the Drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

1-5.02. Conductors. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.

1-5.02.01. Conductor Identification Number. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.

The wire markers shall be of the heat-shrinkable tube type, with custom typed identification numbers.

The wire numbers shall be as indicated on the equipment manufacturer's drawings.

The wire markers shall be positioned to be readily visible for inspection.

1-5.02.02. Conductor Color Coding. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.

The following color-coding system shall be used:

120/240V single-phase — black, red, and white
277/480V, three-phase — brown, orange, yellow, and gray

Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.

1-5.03. Motor Starters. Motor starters shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated white-over-black plastic, with 1/8 inch engraved letters and shall be securely fastened to the motor starters.

1-5.04. Control Stations. Not used.

1-5.05. Circuit Breakers. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated white-over-black plastic, with 1/8 inch engraved letters and shall be securely fastened to the circuit breakers.

1-5.06. Disconnect Switches. Not used.

1-5.07. Arc Flash Hazard Labels. Power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, and other electrical equipment likely to be worked on energized shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

WARNING
Arc Flash and Shock Hazard

Appropriate personal protection equipment (PPE) required. SEE NFPA 70E.
Equipment must be accessed by qualified personnel only.
Turn off all power sources prior to working on or inside equipment.

Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

1-6. SUBMITTALS. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

Drawings and data.
Operating manuals.
Samples.
Test reports
Studies

1-6.01. Submittal Identification. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.

b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.

c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.

d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.

e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.

f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer’s descriptive bulletins and product sheets.

Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing.

Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

1-6.02. Seismic Design Requirements. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1-7. PROTECTION AND STORAGE. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2-1. POWER SERVICE ENTRANCE. Contractor shall consult the local electric utility regarding their service installation requirements and shall furnish the service equipment in compliance with these requirements.

Power service equipment to be furnished by Contractor shall include, but is not limited to, meter board, meter socket, meter test cabinet, meter transformer cabinet, disconnecting means ,grounding materials, riser conduits, and other service entrance fittings required by the utility and for compliance with local codes and regulations.

Contractor shall also provide trenching and backfill, conduits, service cables, concrete for duct banks, and other underground service entrance fittings required by the utility for underground service installation.

A weatherhead shall be provided on each service riser conduit.

2-2. TELEPHONE SERVICE ENTRANCE. Not used.

2-3. CABLE. All cables of each type (such as 600-volt power cable) shall be from the same manufacturer.

All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

2-3.01. Lighting Cable. Not used.

2-3.02. 600 Volt Power Cable. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt (Figure 2-16050 XHHW-2) power cable.

2-3.03. Instrument Cable. Cable for electronic circuits to instrumentation, metering, and other signalling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4-16050 single pair).

2.3.04. Multiconductor Control Cable. Not used.

2-3.05. Medium Voltage Power Cable. Not used.

2-3.06. Tray Cable. Not used.

2-4. CONDUIT. Conduit and raceways shall be as described in the following paragraphs:

2-4.01. Rigid Steel Conduit. Not used.

2-4.02. Intermediate Metal Conduit (IMC). Not used.

2-4.03. Liquid-tight Flexible Metal Conduit. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moisture-proof polyvinyl chloride jacket, and shall be UL labeled.

2-4.04. Utility (PVC) Duct. Not used.

2-4.05. Rigid Nonmetallic (PVC) Conduit. PVC conduit shall be heavy wall, Schedule 40, UL labeled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651.

2-4.06. PVC-Coated Rigid Steel Conduit. The conduit shall be rigid steel. Before the PVC coating is applied, the conduit shall be hot dip galvanized inside and out with hot galvanized threads. The hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils .

A chemically cured two-part urethane coating, at a nominal 2 mil thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.

Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches, whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils .

All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. Fittings shall be Form 8 condulets, ½" through 4" diameters, shall have a v-seal tongue-in-grooved gasket and supplied with plastics encapsulated stainless steel cover screws to effectively seal against the elements. The screw heads on condulets shall be encapsulated with a corrosion-resistant material. Form 8 fittings shall be UL Type 4X and IP69 listed.

A "PVC Coated Sealing Locknut' shall be used on all exposed male threads transitioning in female NPT threads which do not have sealing sleeves, including transitions from PVC coatings / female adapters to PVC-coated GRC elbows in direct burial applications. "PVC Coated Sealing Locknuts" are not to be used in place of a Myers hub.

PVC coated rigid steel conduit shall be UL listed and carry the ETL PVC-001 label. The PVC coasted rigid steel conduit shall be manufactured by Calbond, Plasti-Bond, Perma-Cote, KroKap, or Robroy Industries.

2-4.08. Rigid Aluminum Conduit (RAC). Not used.

2-4.09. Cable Tray. Not used.

2-5. WIRING DEVICES, BOXES, AND FITTINGS. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

2-5.01. Conduit Boxes and Fittings.

a. Stainless steel, threaded, boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.

b. Rigid PVC device boxes and fittings shall be manufactured by Carlon or Cantex.

c. Stainless steel device boxes shall be manufactured by Appleton, Raco, or Steel City.

d. PVC coated device boxes shall be manufactured by Calbond, Plasti-Bond, Perma-Cote, KroKap, or Robroy Industries.

e. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

2-5.02. Device Plates.

a. Stainless steel device plates shall be used on surface mounted outlet boxes where weatherproof plates are not required.

b. Device plates on flush mounted outlet boxes where weatherproof plates are not required shall be AISI Type 302 stainless steel, Eaton "93000 series", Hubbell "S series", or Leviton "840nn-40 series"; nylon or polycarbonate, Eaton "5000 series", Hubbell "Pn series", or Leviton "807nn-I series".

c. Device plate mounting hardware shall be countersunk and finished to match the plate.

d. Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185" or O Z Gedney "FS-1-WSCA".

e. Device plates for receptacles indicated as weatherproof shall be Appleton "FSK-WRD", Crouse-Hinds "WLRD1", or O Z Gedney "FS-1-WDCA.

f. Flush-mounted, weatherproof plates shall be provided with adapter plates, Appleton "FSK-SBA" or Crouse-Hinds "FS031".

g. Device plates for ground fault interrupter receptacles indicated to be weatherproof shall be Appleton "FSK-WGFI", Eaton "S966", or O Z Gedney "FS-1-GFCA".

h. Receptacle covers outdoors or otherwise indicated to be weatherproof while in-use shall be die-cast aluminum and shall include a padlock eye. Covers for standard convenience outlets shall be Hubbell “WP8M” or Thomas and Betts Red Dot “CKMUV”. Covers for ground fault interrupter receptacles shall be Hubbell “WP26M” or Thomas and Betts Red Dot “CKMUV”.

i. Engraved device plates, where required, shall be manufactured by Leviton, or equal.

j. Device plates on PVC conduit fittings shall be Carlon "E98 Series" or Cantex "513300 Series".

2-5.03. Wall Switches.

a. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eaton "AH1221V" through "AH1224V", Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".

b. Switches for pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, center "Off", Eaton "1995V", Hubbell "1557I" or Leviton "1257-I".

c. Switches on ac lighting panel load circuits through 277 volts in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be 20 ampere, 120/277 volts. Hazardous area switches shall be factory sealed tumbler switches, Appleton “EDS” or Killark “FXS”.

2-5.04. Receptacles.

a. Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eaton "AH5362V", Hubbell "5362I" or Leviton "5362-I" for 120-volt circuits, and 250 volts, Eaton "AH5462CV", Hubbell "5462I" or Leviton "5462-I" for 240-volt circuits.

b. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eaton "SGFH20", Hubbell "GF5362I" or Leviton "7899-I".

c. Ground fault circuit interrupter receptacles in damp or wet locations shall be duplex, 20 amperes, 125 volts, Hubbell "GFWRST20I" or Leviton "WT899-HGI".

d. Welding receptacles shall be 30 amperes, 600 volts, 3-phase, with grounding conductors connected through a fourth pole, Appleton "ADRE3034-100", Crouse-Hinds "AR348" plus "ARRC33" and "AR30" or Leviton " 430MI5W". One matching plug, Appleton "ACP3034BC", Crouse-Hinds "APJ3485" or Leviton "430P5W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

e. Welding receptacles shall be 60 amperes, 240 volts, 3-phase, with grounding conductors connected through a fourth pole, Appleton "ADRE6034-150", Crouse-Hinds "AREA6425" or Leviton "460MI9W". One matching plug, Appleton "ACP6034BC", Crouse-Hinds "APJ6485" or Leviton "460P9W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

f. Receptacles in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be three-wire,

grounding, 20 amperes, 125 volts. Hazardous area receptacles shall be factory sealed, with an integral switch that is only activated when an approved matching plug is fully inserted and rotated into the engaged position. Hazardous area receptacles shall be Appleton “ENR”, Crouse-Hinds “ENR”, or Killark “UGR”.

2-5.05. Special Outlets. Not used.

2-6. JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS. Boxes and gutters in corrosive areas indicated on the Drawings and outdoor boxes and gutters shall be NEMA Type 4X, 316 stainless steel and shall be rigidly supported by PVC-coated or 316 stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

Bolt-on junction box covers 3 feet square or larger, or heavier than 25 lbs, shall have rigid handles. Covers larger than 3 by 4 feet shall be split.

Where indicated on the Drawings, junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2-7. LIGHTING FIXTURES. Not used.

2-8. LIGHTING PANELS. Not used.

2-9. POWER PANELS. Not used

2-10. SURGE PROTECTIVE DEVICES. Not used.

2-11. COMBINATION MOTOR STARTERS. As indicated on the Drawings, motor starters, unless otherwise specified, shall be reduced voltage, magnetic, non-reversing and NEMA rated. The starters shall be installed in the Pump Control Panel. Reduced voltage Solid-State (RVSS) starters shall be furnished with across-the-line contactors for use after motor has attained full voltage operating speed motor and for bypass operation upon RVSS fault.

Heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss and unbalance protection, trip class selection, Class II ground fault protection, and manual reset.

Each starter shall include auxiliary contacts as required, plus one spare NO and one spare NC contact.

Contractor shall match the sizes of control power transformers, overload devices, heaters, and starters to the equipment furnished, as they may differ from the values indicated on the Drawings. Control power transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.

All starters shall be provided with control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.

All push buttons, selector switches, and pilot lights indicated on the schematics to be provided on or in the starter enclosure shall be 30.5 mm heavy-duty, oil-tight construction. Pilot lights shall be full voltage type with push-to-test LED lamps. Push buttons on starters located outdoors shall be provided with protective caps.

2-11.01. Three Phase Starters. Three phase starters shall be circuit breaker combination type consisting of 3 phase, 60 Hz contactors with heater-less overloads, a 120 volt ac coil, a dry type control power transformer where required, and a circuit breaker disconnect. Control power transformers shall be sized to handle all simultaneous loads. Starters shall be at least Size 1, or shall be sized as indicated on the Drawings.

Circuit breakers shall be 600 volt magnetic motor circuit protectors for motors smaller than 100 horsepower and 600 volt thermal-magnetic type for 100 horsepower and larger motors. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism.

Three phase starters shall be furnished with external manual breaker operating handles and provisions for up to three padlocks. The access door shall be interlocked with the motor circuit protector, so that the door cannot be opened, except by an interlock override, while the breaker is closed.

The complete 3 phase starter shall have an interrupting rating of at least 14,000 amperes at 480 volts.

2-11.02. Single Phase Starters. Single phase starters shall consist of single phase, 60 Hz contactors with thermal overloads and an integral or separately enclosed short-circuit protection device. Starters shall be at least NEMA Size 0, or shall be sized as indicated on the Drawings. Integral short-circuit protection devices for single-phase starters shall be 120/240 volt, magnetic motor circuit protectors.

Separately enclosed short-circuit protection devices for single phase starters shall be molded-case circuit breakers for motor loads 6 amperes and higher and fused switch disconnects for motor loads lower than 6 amperes. Circuit breaker disconnects shall be 120/240 volt, molded-case, thermal-magnetic circuit

breakers. Fused switch disconnects shall have quick-make, quick-break mechanisms and 250 volt, dual-element, time-delay fuses.

The short-circuit protection devices shall have external operating handles capable of being padlocked in the open position, and shall have an interrupting rating of at least 10,000 amperes at 240 volts.

2-12. SEPARATELY ENCLOSED MANUAL STARTERS. Not used.

2-13. CONTROL STATIONS. Not used.

2-14. SEPARATELY ENCLOSED CIRCUIT BREAKERS. Circuit breakers shall be 3 pole, 480 volt, molded-case circuit breakers of not less than 65,000 amperes interrupting rating at 480 volts ac, complete with thermal and instantaneous trip elements. Breaker enclosures shall have NEMA designations appropriate for the locations where they will be installed. NEMA Type 4X stainless steel enclosures shall be provided for outdoor locations. Each breaker shall be manually operated with a quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration.

Circuit breakers shall have "On", "Off", and "Tripped" indication and padlockable exterior handles.

2-15. DISCONNECT SWITCHES. Not used.

2-16. LIGHTING AND AUXILIARY POWER TRANSFORMERS. Not used.

2-17. POWER CENTERS. Power centers shall consist of a primary breaker, a 480-120/240 volt or 480-120/208 volt transformer, a secondary breaker, and a distribution panelboard in a NEMA Type 4X enclosure. Transformer and circuit breaker configuration and ratings shall be as indicated on the Drawings.

2-17.01. Transformers. Transformers shall be self-air-cooled, epoxy-resin encapsulated dry type with a 115 degree C temperature rise. Transformers shall have at least two full capacity voltage taps.

2-17.02. Circuit Breakers. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers and provisions for future breakers shall be provided in the quantities, poles, and ampere ratings indicated on the Drawings. Breakers shall be single pole, 20 amperes, except as indicated otherwise.

2-18. POWER FACTOR CORRECTION CAPACITORS. Not used.

2-19. LIGHTING CONTACTORS. Not used.

2-20. PHOTOELECTRIC CONTROLS. Not used.

2-21. RELAY ENCLOSURES. Not used.

2-22. ALARM HORN AND BEACON. The alarm horns and beacons shall be provided and located as indicated on the Drawings. The beacon shall be 120 VAC, strobe light with clear lens and acrylic dome, Edwards "Model No. 94C-N5" or Federal Signal "Model 371DST". The alarm horn shall be 120 VAC, weatherproof horn, Edwards "Model No. 876-N5" or Federal Signal "Model 350WB".

2-23. HEAT-TRACED PIPING. Not used.

2-2~~3~~**4**. POWER METERING. Not used.

2-25. PORTABLE GENERATOR RECEPTACLE. 200A load breaking Portable generator receptacle with angle adapter and junction box. Russell Stoll MAX GARD series or approved equal. Connection shall be rated for 480, 3 phase, 3 wire plus ground. The receptacle shall be rated for 200A continuous current. Contractor shall coordinate generator receptacle pin configuration with Owner's generator plug

PART 3 - EXECUTION

3-1. INSTALLATION, TESTING, AND COMMISSIONING. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3-2. ARC FLASH HAZARD ANALYSIS. Contractor shall commission an Arc Flash Hazard Analysis for each piece of electrical equipment including power centers, transfer switches, industrial control panels, and other electrical equipment likely to be worked on energized, in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584 and shall submit an Arc Flash Hazard Analysis report as specified herein.

The scope of the analysis shall include all electrical equipment at the pump station, beginning with the electric utility meter socket or service entrance equipment down to three-phase ac equipment operating at 208V and above.

The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study.

Protective-device settings shall be selected to providing the necessary equipment protection and device coordination required while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

The Arc Flash Hazard Analysis shall calculate the arc flash protection boundary and the arc flash incident energy at defined working distances for the locations specified in the analysis. The analysis shall be performed for multiple electrical system modes of operation in order to calculate the worst-case incident energy at each piece of equipment. At a minimum, the system shall be analyzed for the minimum and maximum available fault current and X/R ratios from the electric utility supplying service or for the separately derived power system. The Contractor shall be responsible for obtaining the available fault current values from the local electric utility. The analysis shall not assume bolted fault current values.

For equipment with an integral main overcurrent protective device that is not adequately isolated from the bus, the upstream protective device shall be used as the fault clearing device in the analysis. Where arc reduction maintenance mode switches are installed on protective devices, the arc reduction shall only apply for downstream equipment that is adequately isolated from the protective device. Adequately isolated equipment shall be confirmed by the equipment manufacturer and shall be submitted to Engineer for review.

The Contractor shall be responsible for collecting all field data for a complete analysis. Assumptions should only be made after every effort has been made to obtain the needed information. All assumptions used in the analysis shall be documented in the report for review by Engineer.

The results shall include, but shall not be limited to, a tabulated spreadsheet of the following items for each piece of equipment included in the analysis:

Equipment name.

Three-phase bolted fault current.

Arcing fault current.

Arcing fault current through the protective device.

Protective device clearing the fault.

Protective device opening time.

Bus gap.

Worst-case incident energy and corresponding working distance. Equipment with arc reduction maintenance mode switches shall include the calculated incident energy level with and without the switch enabled.

Arc flash protection boundary.

An Engineering and Testing Services firm acceptable to Engineer shall conduct the Arc Flash Hazard Analysis.

3-2.01. Arc Flash Analysis Software. The Arc Flash Hazard Analysis shall be performed using the latest version of ETAP electrical power system analysis

software, without exception. After the final version of the study and analysis are completed and accepted, Contractor shall provide two (2) copies of the ETAP electronic model file to Owner.

3-2.02. Arc Flash Hazard Report.

Contractor shall be responsible for submitting complete and accurate arc flash analysis information in the Arc Flash Hazard Report. The report shall be submitted to Engineer for review before the final report is prepared. Contractor shall ensure that calculated values for arc flash-protection boundary, working distance, incident energy, and required Personal Protective Equipment is submitted and provide substantiation that the information will be prominently displayed on electrical equipment.

The report shall include the following information at a minimum:

Executive summary.

Description of scope and study methodology.

Documentation of the modes of operation evaluated in the analysis including applicable input data such as utility fault current values.

Discussion of results and any recommendations.

Tabulated results spreadsheet.

List of assumptions.

One-line diagram(s) from the computer model software showing equipment names and other applicable information.

Documentation of software study parameters and configuration settings.

Recommended arc flash Personal Protective Equipment (PPE) selection in accordance with NFPA 70E.

The Arc Flash Hazard Analysis report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittal Procedures section. Final selection of required Personal Protective Equipment shall be subject to review and acceptance by Engineer.

The final report shall be signed and sealed by a registered Professional Engineer.

3-2.03. Arc Flash Labeling. After approval of the Arc Flash Hazard Report, Contractor shall furnish and install arc flash labels on the applicable electrical equipment. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.

Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled for the lower incident energy level to apply.

3-3. PROTECTIVE DEVICE STUDY. Contractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the entire distribution system, including any and all existing power distribution components which will impact the results of the protective device study, starting with the smallest 480 volt, 3 phase, 60 Hz circuit protective device on the load end, to the nearest protective device on the power company's line side. Where existing electrical distribution system components are part of the study, the Contractor shall field verify and report the respective ratings and settings of each device as found as a prerequisite to the study analysis being performed. Protective device settings shall be selected to provide selective coordination to the maximum extent possible for equipment protection and device coordination while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

Contractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers shown on the Drawings and Specifications are sized and set according to the study results.

The study shall include, but shall not be limited to, the following:

Color-coded printouts of coordination curves prepared with calculation software.

A tabulation of all protective relay and circuit breaker trip settings and recommended sizes and types of medium-voltage fuses.

Motor starting profiles for all 50 horsepower and larger motors.

Transformer damage curves and protection, evaluated in accordance with IEEE C57.109.

Generator damage curves and protection, evaluated in accordance with manufacturers recommendations.

Coordination curve(s) from the power company, if available.

Calculated short-circuit values at all nodes in the distribution system included within the scope of the protective device study.

Protective device settings shall include, but not limited to, motor and pump RTD settings, motor starts per hour, bus and transformer differential settings, synch-check settings, under and over-voltage settings, under and over-frequency settings, low-voltage breaker and MCC starter overload settings, and all protective functions shown on the Drawings and Specifications

Adjustable frequency drive settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements

Reduced voltage starter settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements

An Engineering and Testing Services firm acceptable to Engineer shall conduct the protective device study.

Contractor shall be responsible for obtaining the following:

The coordination curves for relays, fuses, and circuit breakers.

Transformer damage curves.

Motor and pump data.

Generator data

Other applicable information for all new and existing electrical equipment.

Contractor shall coordinate with the power company to obtain the required protective device curves and shall be responsible for all the field work associated with obtaining the necessary data on existing relays, circuit breakers, fuses, and transformers to be included in the protective device study.

The available 3 phase, symmetrical fault current at the point of service shall be obtained from the Power Company.

The protective device report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittal Procedures section. Final selection of all protective device settings or sizes shall be subject to review and acceptance by Engineer.

3-4. POWER AND SERVICE ENTRANCE INSTALLATION. Contractor shall consult the local electric utility regarding their service installation requirements, and shall install the service equipment in compliance with these requirements. Contractor shall install all power service equipment components except for components installed by the utility as directed in the utility service installation requirements.

Contact information for the electric utility is as follows:

Name of electric utility	Keys Energy
Electric utility contact person and telephone number	Matthew Alphonso Engineering Supervisor (305) 295-9380

Contractor shall coordinate details and timing of service entrance installations with the utility. Contractor shall complete and submit service applications to the electric utility as necessary.

3-5. TELECOMMUNICATIONS SERVICE ENTRANCE INSTALLATION. Not used.

3-6. CABLE INSTALLATION.

3-6.01. General. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer.

a. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

b. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for splicing solid cable and for terminations at lighting fixtures.

c. Splices may be made only at readily accessible locations.

d. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.

e. Not used.

f. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

g. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".

h. Not used.

i. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.

j. Spare cable ends shall be taped, coiled, and identified.

k. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer.

l. All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

m. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.

n. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.

o. Not used.

3-6.02. Underground Cable Pulling Procedure. Not used.

3-6.03. Medium-Voltage Cable Insulation Test. Not used.

3-7. CONDUIT INSTALLATION. Contractor shall be responsible for routing all conduits. This shall include all conduits indicated on the riser diagram. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.

Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.

Installation of PVC Coated Conduit Systems shall be performed in accordance with the Manufacturer's Installation Manual. To assure correct installation, the installer shall be certified by the Manufacturer to install coated conduit and provide a valid, unexpired installer certification card.

3-7.01. Installation of Interior and Exposed Exterior Conduit. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:

a. Not Used.

b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.

c. Conduit installed in all exposed outdoor locations shall be PVC-coated rigid steel, rigidly supported by PVC-coated framing materials. Mounting hardware, which includes nuts, bolts, and

anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquid-tight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet unless otherwise acceptable to Engineer.

e. Not Used.

f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.

h. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues.

i. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type on the Drawings shall be rigid Schedule 80 PVC. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.

j. Rigid Schedule 40 and 80 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.

k. Metallic conduit connections to stainless steel enclosures shall be securely fastened by stainless steel locknuts inside and outside.

l. Rigid Schedule 40 and 80 PVC conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.

m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.

n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concrete-tight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 or 80 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.

o. Conduit shall be clear of structural openings and indicated future openings.

p. Conduits through roofs or metal walls shall be flashed and sealed watertight.

q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire ratingas indicated on the Architectural Drawings.

r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

s. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

u. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

v. Horizontal conduit shall be installed to allow at least 7 feet of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.

w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.

x. PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.

y. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

z. Conduit which turns out of concrete slabs or walls, shall be connected to a 90-degree elbow of PVC-coated rigid steel conduit before it emerges. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.

aa. Conduit for Heliax type foam dielectric coaxial cable shall be installed as follows:

Heliax Size inches	Minimum Conduit Size inches	Minimum Conduit Bend Radius inches
1/2	1-1/2	10

ab. Power conductors to and from adjustable frequency drives shall

be installed in steel conduit.

3-7.02. Underground Conduit Installation. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:

a. All underground conduits shall be concrete encased unless indicated otherwise on the Drawings. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall be reinforced as detailed on the Drawings.

b. Concrete encased conduit shall be schedule 40 PVC. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.

c. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches above grade, with top crowned and edges chamfered.

d. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.

e. Underground conduits indicated not to be concrete encased shall be rigid Schedule 40 PVC.

f. Underground conduit bend radius shall be at least 2 feet at vertical risers and at least 3 feet elsewhere.

g. Underground conduits and conduit banks shall have at least 2 feet of earth cover, except where indicated otherwise.

h. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.

i. Underground nonmetallic conduits, which turn out of concrete or earth in outdoor locations, shall be connected to 90 degree elbows of PVC-coated rigid steel conduit before they emerge.

j. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.

k. Underground conduits shall be sloped to drain from buildings to manholes.

l. Not used.

m. Not used.

n. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.

3-7.03. Sealing of Conduits. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch and larger conduit connections to equipment.

Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.

3-7.04. Reuse of Existing Conduits. Existing conduits shall not be reused.

3-7.05. Cable Tray Installation. Not used.

3-8. WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION. Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

3-8.01. Conduit Boxes and Fittings.

a. Stainless steel, threaded boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.

b. Not Used.

c. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

d. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

e. Not Used.

3-8.02. Device Plates. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

3-8.03. Wall Switches.

a. Wall switches shall be mounted 3'-6" above floor or grade.

b. After circuits are energized, all wall switches shall be tested for proper operation.

3-8.04. Receptacles.

a. Convenience outlets shall be 18 inches above the floor unless otherwise required.

b. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.

c. Welding receptacles shall be surface-mounted 4 feet above the floor.

d. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.

e. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Contractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.

3-8.05. Special Outlets. Not used.

3-9. EQUIPMENT INSTALLATION. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.

3-9.01. Setting of Equipment. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable

or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.

3-9.02. Sealing of Equipment. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

3-10. GROUNDING.

3-10.01. General. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:

a. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.

c. Ground cable through exterior building walls shall enter within 3 feet below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch copper disc over the cable.

d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches . The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches below grade, or below the frost line, whichever is deeper.

e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.

f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.

g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches .

i. Ground rods not described elsewhere shall be a minimum of 3/4 inch in diameter by 10 feet long, with a copper jacket bonded to a steel core.

j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

3-10.02. Grounding System Resistance. The grounding system design depicted on the Contract Drawings is the minimum design required for each building or structure. Each system shall comply with the maximum resistance of 5 ohms to ground. Contractor shall confirm the system grounding resistance with the results of the testing specified herein. Systems exceeding the maximum resistance specified shall be supplemented with additional grounding provisions and retested until the maximum specified resistance is achieved.

3-10.03. Grounding System Testing. The grounding system of each new building or structure and each existing building or structure indicated below, shall be tested to determine the resistance to earth. Testing shall be performed by an independent electrical or grounding system testing organization. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.

3-10.03.01. New Grounding Systems. The grounding system of each new structure shall be tested for resistance to earth utilizing the three-point fall of potential test as defined by IEEE 81. Testing shall be completed prior to installation of the electrical distribution equipment to ensure the grounding system is isolated from the utility grounding system and the systems of other

structures. The current source probe for the test shall be placed in soil at a distance of 5 to 10 times the distance of the widest measurement across the grounding system ring or grid to ensure adequate measurements outside of the grounding system's sphere of influence. Test probe measurements shall be taken at a distance of one foot from the grounding system reference connection and at each 10 percent increment from the grounding system reference connection to the current source probe location. Test results shall be documented on a graphical plot with resistance in ohms on the vertical axis and distance in feet on the horizontal axis. The results shall clearly indicate a system resistance plateau which confirms a valid test procedure.

3.10.03.02. Existing Grounding Systems. Not used.

3.10.03.03. Grounding System Test Report. A report certified by the testing organization shall be prepared and submitted in accordance with the Submittal Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Engineer.

3-11. LIGHTING FIXTURE INSTALLATION. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3-12. POWER FACTOR CORRECTION CAPACITOR INSTALLATION. Not used.

3-13. HEAT-TRACED PIPING INSTALLATION. Not used.

3-14. MODIFICATIONS TO EXISTING EQUIPMENT. Not used.

End of Section

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.

INSULATION: Cross-linked thermosetting polyethylene, ICEA S-95-658, Paragraph 3.6.

SHIELD: None.

JACKET: None.

FACTORY TESTS: Cable shall meet the requirements of ICEA S-95-658.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
14	2.5	7	0.030	760	0.17	4.32
12	4.0	7	0.030	760	0.19	4.83
10	6.0	7	0.030	760	0.21	5.33
8	10.0	7	0.045	1140	0.27	6.86
6	16.0	7	0.045	1140	0.31	7.87
4	25.0	7	0.045	1140	0.36	9.14
2	35.0	7	0.045	1140	0.42	10.67
1	40.0	19	0.055	1400	0.48	12.19
1/0	50.0	19	0.055	1400	0.52	13.21
2/0	70.0	19	0.055	1400	0.57	14.48
4/0	95.0	19	0.055	1400	0.68	17.27
250	120.0	37	0.065	1650	0.75	19.05
350	185.0	37	0.065	1650	0.85	21.59
500	300.0	37	0.065	1650	0.98	24.89
750	400.0	61	0.080	2030	1.22	31.00
1,000	500.0	61	0.080	2030	1.37	34.80

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.

600 Volt, Single Conductor Lighting/Power Cable (600-1-XLP-NONE-XHHW-2)

BLACK & VEATCH	Cable Data	Figure 2-16050

STANDARD SPECIFICATIONS

REFERENCE: UL 66, UL 1277.

CONDUCTOR: 16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 66, Type TFN.

LAY: Twisted pair with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.

SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 66.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	μm	in.	mm
Single Pair	0.045	1140	0.34	8.64

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.

600 Volt, Single Pair, Shielded Instrument Cable (600-SINGLE-PAIR-SH-INSTR)

BLACK & VEATCH	Cable Data	Figure 4-16050