

CITY OF AUSTIN, TEXAS  
PURCHASE SPECIFICATION

FOR

**LOST CREEK WASTEWATER TREATMENT PLANT  
SELF-PRIMING CENTRIFUGAL PUMP FOR HIGH SERVICE EFFLUENT**

1.0 SCOPE AND CLASSIFICATION

1.1 Scope

This specification establishes the minimum requirements for the purchase of a self-priming centrifugal pump to pump treated effluent to the golf course ponds in the Lost Creek development. Contractor shall provide specified equipment and appurtenances and deliver the new pump to the Lost Creek Wastewater Treatment Plant. The pump will be installed by Others.

Contractor shall include time for a factory-trained representative to visit the site and verify proper installation and operation.

This specification includes sections on Scope and Classification, Applicable Specifications, Contractor Requirements, Performance Requirements, and Invoicing Requirements.

1.2 Classification

The self-priming centrifugal pump will be located at Austin Water Utility's Lost Creek Wastewater Treatment Plant, 6104 ½ Turtle Point Road, Austin, TX, 78746.

<u>Date</u>	<u>Prepared by</u>	<u>Issuance/Revision</u>	<u>Approval Department</u>	<u>Approval Purchasing</u>
4-22-2015	Henry Dress	Issuance	Darrell Richmond	Steve Aden

This specification, until revised or rescinded, shall apply to each future purchase and contract for the commodity describe herein. Retain for future use.

## 2.0 APPLICABLE SPECIFICATIONS

2.1 Contractor will be responsible for complying with all Federal and State of Texas standards, including but not limited to rules, regulations, and laws concerning this type of service, including EPA standards that apply to both private industry and governmental agencies. This also includes compliance with applicable OSHA safety guidelines and City of Austin ordinances and regulations, as well as Austin Water Utility (AWU) policies.

2.2 Attachment A, which is comprised of the following technical specification sections, item, schematic and details:

11301 Self-Priming Horizontal End Suction Centrifugal Pump

WW 16010 Electrical General Provisions

16150 Raceways, Fittings and Supports

WW 16172 Electric Motor 200hp and Smaller

WW 16191 Miscellaneous Electrical Equipment

16200 Wires, Conductors and Cables – 1000V and Below

WW 16205 Wire Tagging

WW 16700 Common Control Panel Requirements for Equipment

Pump Replacement Schematic

Pump Control Schematic

Wetwell Section drawing

Existing pump photo

## 3.0 CONTRACTOR REQUIREMENTS

3.1 Provide equipment and appurtenances complying with technical specification sections, section and schematic in Attachment A.

3.2 Send factory-trained representative onsite to inspect and verify proper system installation.

## 4.0 PERFORMANCE REQUIRMENTS

4.1 The Contractor shall contact the Contract Manager within **five calendar days after award of contract** to establish and mutually agree upon installation duration and schedule and to coordinate with plant operations.

4.2 Contract Manager:

Lauren King, PE

Austin Water Utility, Facility Engineering

625 E. 10<sup>th</sup> Street, Suite 400

Austin, TX 78701

(512) 972-0230

## 5.0 INVOICING REQUIREMENTS

5.1 Invoices shall not arrive prior to project completion. Contractor shall submit an invoice within ten (10) calendar days after substantial completion, which shall be defined by complete commissioning and onsite verification by factory-trained representative of proper system installation and operation.

Lauren King, PE

Austin Water Utility, Facility Engineering

625 E. 10th Street, Suite 400

Austin, TX 78701

- ◇ Invoice shall include, but is not limited to, the following:
- ◇ Contractor's name, on a professionally pre-printed form
- ◇ Contractor's address and phone number
- ◇ City's contract number/purchase order number
- ◇ Date of delivery
- ◇ Location of delivery
- ◇ Itemized description and pricing for each item listed on the bid sheet.
- ◇ Final Invoice shall include "FIXED ASSET PROCESSING FORM" (Attachment B) with all applicable fields completed

# **Attachment A**

**SECTION 11301****SELF-PRIMING CENTRIFUGAL PUMP****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. This Section specifies a single stage, self-priming, belt driven, horizontal centrifugal pump with overhung impeller and complete with electric motor and all appurtenances.
- B. Contractor shall provide new pump, motor, and controls. Demolition of existing pump, motor, drive and controls will be by Others. Installation of new pump and connection of new equipment and instrumentation to 120V power and 480V power will also be by Others.
- C. Contractor shall supply all equipment, base, parts, devices, components, controls and instrumentation necessary to provide a completely operational pump which meets the requirements of this section and good engineering practices.

**1.02 RELATED WORK SPECIFIED ELSEWHERE:**

- Specification Section WW 16010: Electrical General Provisions
- Specification Section 16150: Raceways, Fittings and Supports
- Specification Section WW 16172: Electric Motors, 200 hp and Smaller
- Specification Section WW 16191: Miscellaneous Electrical Equipment
- Specification Section 16200: Wires Conductors Cables - 1000V and Below
- Specification Section WW 16205: Wire Tagging
- Specification Section WW 16700: Common Control Panel Requirements for Equipment
- Lost Creek WWTP HSE Pump Control Schematic
- Lost Creek WWTP HSE Pump Schematic
- Wetwell section drawing

**1.03 GENERAL REQUIREMENTS**

- A. Electrical General Provisions of Specification Section WW 16010 shall be provided;
- B. Electrical installation shall comply with the provisions of Specification Section 16150;
- C. Electric motor shall comply with provisions of Specification Section WW 16172;
- D. Miscellaneous electrical components shall be provided in compliance with Specification Section WW 16191;
- E. Wiring shall be comply with the requirements of Specification Section 16200;
- F. Wire tagging shall comply with the requirements of Specification Section WW 16205; and
- G. Control panel shall comply with the applicable requirements of Specification Section WW 16700.

H. Pump and motor shall have position location identification labels per the following table:

Pump	Motor
PP-LC-NP-201-A	PP-LC-NP-201-M

#### 1.04 REFERENCE STANDARDS

This Section contains multiple references to industry standards. They form a part of this Section as specified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ANSI A21.11 /AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
ANSI A21.15/ AWWA C115	Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
ANSI B1.20.1	Pipe Threads, General Purpose, Inch
ANSI B15.1	Safety Standard for Mechanical Power Transmission Apparatus
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24
ASTM A48	Cast Iron Castings

#### 1.05 SUBMITTALS

Submit the following with bid documents:

- A. Manufacturer's data: dimensions, materials of construction, and accessories for all components including motor.
- B. Performance curve developed for the specific application. Performance curve shall show speed, capacity, pressure, and power for specified conditions.
- C. A complete and full description of any deviations from or exceptions to the specifications shall be provided by the Contractor. The submittal shall be accompanied by a detailed, written explanation/justification for each deviation.
- D. List of recommended spare parts.

Submit the following after project award:

- E. Applicable calculations indicating basis of design for the system.
- F. Shop drawings, dimensioned and to scale as appropriate, (including arrangement and layout drawings, equipment and skid details). Drawings shall be submitted in electronic format as well as paper copies. A minimum of two paper copies of each drawing shall be submitted. Any resubmitted (and as-built) drawings shall include electronic and hard copies with all changes noted.
- G. Complete wiring and control diagrams.
- H. Manufacturer's pump performance curve along with certified shop test report.

Submit the following to close out the project:

- I. Operation and maintenance manuals including, as a minimum, complete installation, operation and maintenance instructions, troubleshooting guides and copies of all approved shop drawings. Videos, photographs, and other material which may aid in the preparation of the O&M manual, as well as training material, shall also be submitted.
- J. Equipment and system warranty letter indicating date of Owner acceptance and duration of warranty.

#### 1.06 DELIVERY, HANDLING, STORAGE AND PROTECTION

- A. Contractor is responsible for safe delivery of all products to Wastewater Treatment Plant site.
- B. Upon receipt, Owner will inspect and notify manufacturer of any problems/damage or confirm successful delivery. Shipments will be inspected upon delivery to ensure products:
  - Are properly labeled and identified and date of manufacture is clearly visible;
  - Comply with the requirements of this specification section; and
  - Quantities match those on Bill of Lading.
- C. Pump shall be completely drained prior to shipment. Pump shall be secured to a its skid and crated to facilitate handling and storage. Cover or plug all openings to keep out dirt and foreign matter.
- D. Transport and handle products at all times in a manner suitable to avoid product damage.
- E. Deliver dry and in undamaged condition in the manufacturer's unopened containers or packaging.
- F. Any products damaged during delivery shall be returned to Contractor and replaced with undamaged products at no additional cost to the Owner.
- G. Pump and accessories shall be stored and protected in accordance with the manufacturer's recommendations.

#### 1.07 QUALITY ASSURANCE

- A. Manufacturer shall perform factory test to demonstrate compliance with the specified operating conditions and to produce a pump performance curve. The performance curve shall include the following six points:
  1. Rated capacity, i.e., guarantee point
  2. Shut off
  3. Midway between shut off and minimum stable flow
  4. Minimum stable flow
  5. Midway between minimum stable flow and rated flow
  6. Runout, i.e., minimum head

Plot the pump flowrate, discharge pressure, horsepower requirements and efficiency lines adjusted to reflect the fluid being pumped.
- B. The Owner shall be given a minimum two week notice of the test data. Owner reserves the right to witness testing of the pump at the Manufacturer's facility.

## 1.08 WARRANTY

- A. Contractor shall provide both equipment and system warranties. Manufacturers' warranties shall cover 100% parts (including, but not be limited to mechanical seal, wear plates, housing segments, and motor) and the Contractor's warranty shall cover instrumentation and assembly and field service labor.
- B. Pump shall be free of defects in design, material, workmanship and installation for a period of 12 months from the date of Owner acceptance. If any part of the equipment should fail during the warranty period including as a result of wear and tear, it shall be repaired and restored to full and compliant service at no expense to the Owner. A non-Manufacturer's warranty is unacceptable.
- C. Manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

## PART 2 PRODUCTS

### 2.01 MANUFACTURER

Provide one self-priming centrifugal pump as manufactured by one of the following, along with an electric motor and all necessary accessories and appurtenances:

- Cornell, STX Series
- Ebara Fluid Handling, Model EFQU
- Flowserve, Model MPT;
- Gorman-Rupp, Super T-Series;
- Hydromatic, RP, MP or RDP Series; or
- Owner approved equal.

### 2.02 DESIGN REQUIREMENTS:

- A. The pumping unit shall be a self-priming, horizontal, centrifugal pump, specifically designed for pumping water with some free solids.
- B. Pump and motor shall be designed and selected for continuous duty pumping of wastewater effluent subject to secondary treatment. Pumped effluent is expected to range in temperature between 45 degrees and 85 degrees °F depending on the season, and have a pH range between 6 and 9, with a free chlorine residual that could occasionally exceed 10 mg/L.
- C. Pump shall have a back pull-out design to facilitate inspection and maintenance.
- D. Rotating components shall be statically and dynamically balanced. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided.
- E. Bearings shall be oil-lubricated.
- F. Pump hydraulic efficiency at design point shall be  $\geq 50\%$ .
- G. Shaft shall be of sufficient size to transmit the full driver horsepower with a deflection of no more than 0.001 inches.

2.03 OPERATING REQUIREMENTS:

Pump provided under this specification shall be designed for the operating capacity and head of liquid in the table below.

Pump Design Capacity, gpm	Pump Design Total Differential Head, ft	Maximum Shutoff Head, ft	Max. NPSH reqd. ft.	Min. Reprime Lift Required, ft	Pump shall pass min. Solids Sphere, inches
375	83	110	12	17	1.5

- A. The pump shall not overload the motor at any point on the pump performance curve within the limits of stable pump operation.
- B. Noise level of entire pump assembly shall be no greater than 85 dB at 5 feet and meet all OSHA requirements for noise.

2.04 PERFORMANCE REQUIREMENTS:

- A. There shall be no significant change in vibration and noise level over the entire listed range of operating conditions of operating conditions of the pumping system.
- B. Motor shall be non-overloading (not including motor's 1.15 service factor) along all points of the operating line as evidenced by the shop test's performance curve.

2.05 MATERIALS

Pump Component	Materials of Construction
Casing, coverplates and wearplates	Cast iron ASTM A48
Impeller	Cast or ductile iron
Shaft	AISI 4140 alloy steel or 400 series stainless steel
Flanges	Class 125/Class 150 (ASME B16.1/ASME B16.5)

2.06 PUMP COMPONENTS

- A. Cover plates shall be easily removable for pump inspection without the need to disconnect piping.
- B. Wearplate(s) shall be easily removed and be replaceable as needed.
- C. Impeller shall be semi-open style with pump out vanes to keep solids away from seal faces. Key impeller to shaft and secure using a lock nut that is easily removable without special tools.
- D. Internal flap valve shall be a solid, one piece valve.
- E. Cartridge style mechanical seal with two hard silicon (or tungsten) carbide seal faces. The cartridge shall include the mechanical seal faces, the seal holder and carrier, and all o-rings, which shall be compatible with seal flush. Seal shall be oil-flushed.
- F. Provide an oversized pump shaft of alloy steel or stainless steel.
- G. Cover plates shall use a nitrile rubber o-ring or gasket and quick removal bolts.

- H. Pump end connections shall be 4-inch or 6-inch Class 125/150 ANSI B16.1/B16.5 flanges.
- I. Provide heavy-duty, oversized bearing assembly with oil-lubricated ball bearings designed to carry both radial and thrust loads at both ends of the frame.
- J. Bearings shall be rated a minimum AFBMA L<sub>10</sub> average life of 100,000 hours and mounted in machined and dust-proof housings.

#### 2.07 MOTOR AND DRIVE UNIT:

- A. Existing pump has a 25 hp motor. Provide a motor in accordance with Specification Section 16172 and this section, preferably no larger than 25 hp.
- B. Pump shall be V- belt driven with appropriate sheaves to reduce the motor speed to the desired rate for the pump. Drive shall have OSHA compliant guard(s) (ANSI B15.1) of metal construction, securely mounted to skid or base.
- C. Provide a TEFC squirrel cage induction motor with a 1.15 service factor and a standard frame size suitable for operation using a 480-volt, 3-phase, 60-Hertz power supply.
- D. Non-contacting bearing isolators conforming to IP 55 shall be supplied for all motor ball bearings.
- E. Maximum motor speed shall not exceed 1800 rpm.

#### 2.08 PUMP SUPPORT AND BASE

- A. The pump and drive assembly shall be rigidly mounted on a common heavy-duty fabricated structural steel channel-frame that will be anchored on top of the wetwell (installation by Others.) Welds shall be continuous. Mounting surfaces for the equipment shall be machined flat and parallel with 0.002 inch overall run end-to-end and side-to-side.
- B. Pump and drive assembly mounted on the fabricated structural steel channel-frame shall be sized to match elevations of existing piping as well as dimensions of new pump and motor.
- C. Stainless steel anchor bolts: provide sufficient length to anchor skid to top of wetwell wall. Provide leveling screws, one at each skid bolt hole to facilitate leveling of base and provide horizontal positioning screws and slots for pump and motor, to facilitate alignment.
- D. Pump and motor base shall have a lip around its perimeter that shall drain back into the wetwell.
- E. Steel base shall be primed and painted. Manufacturer shall provide a coating system to withstand the low pH moisture droplets that can be emitted from the wetwell and settle on the steel.

#### 2.09 PUMP CONTROL

- A. Pump will be controlled by existing float switches in wetwell (high level float on/low level float off). Pump shall have a Hand-Off-Automatic handswitch to allow direct local control or automatic control based on the wetwell floats. See HSE Pump Control Schematic.

## 2.10 ANCILLARY ITEMS

- A. Priming connection; provide valved connection on pump or flanges to allow hose connection. Install 3/4" Sch. 80 steel nipple, 3/4" ball valve (NIBCO T-570-CS-R-66 or equal) and 3/4" FNPT x 1/2" MHT fitting for initial connection of water hose to prime pump.
- B. Air bleed connection; provide ball valved air bleed connection at point pump high point so pipe can be routed to below pump off water level. Alternatively, install an Air Release Valve in pump discharge line upstream of check valve, Val-Matic Series 15A.3 with a 1" FNPT inlet, a 1/2" FNPT outlet and a 1/16" diameter orifice.
- C. Gaskets; 1/8-inch minimum thickness nitrile rubber (Garlock 9122 or equal).
- D. Hand-Off-Auto selector switch: local, 3-position, non-illuminated selector switch for pump control with Hand-Off-Auto positions, heavy duty, NEMA 4/13 dust and water tight, full-size 30-mm diameter, contacts rated for minimum of 10 amps at 120 VAC. Furnish each position/function of selector switch with one additional normally open contact and also one additional normally closed contact. Furnish and install with HOA legend plate per manufacturer's standard with inscription. Allen Bradley, Model "Knob Lever Operator" Catalog No. 800T-J17A or equal.
- E. Pilot Light: Transformer type, LED, push to test style, colored lens, rating NEMA 4/13 dust and watertight, metal, rated for 10A minimum at 120VAC, full-size 30-mm diameter, Allen Bradley Catalog Nos. 800T-PTH16G (STOP) and 800T-PTH16R (RUN) or equals.
- F. Enclosures: NEMA-4X Type 316 Stainless Steel gasketed cabinet enclosure.
- G. Instrument stand for handswitches: Base-mounted to pump/motor skid, pipe style, O'Brien Corp., Saddlepak® Model FS52, field-erected stainless steel Unistrut, or equal.

## 2.11 SPARE PARTS

- A. One set of any specialized tools for servicing the pump shall be provided as well as the following spare parts.
  - 1 – set of wear plates
  - 1 – set of belts and sheaves
- B. Spare parts shall be identified, tagged and packaged to prevent dirt and moisture from damaging parts during storage.

## 2.12 NAMEPLATES AND LABELS

- A. Provide pump and motor with nameplates using 1/8" thick Type 316 stainless steel. Engrave with Arial or similar font, 1/4" tall letters minimum. Punched for screws and fastened to equipment at factory in an accessible and visible location.
- B. Identify controls and starter with labels, provide 3-ply, rigid, thermosetting phenolic resin engraving stock, 1/8" thick to label devices. Colors: white-black-white. Engrave with Arial or similar font, 3/4" tall letters and numerals minimum, through top layer to melamine layer. Punched for screws.
- C. Fasteners: Self-tapping stainless steel screws, except contact epoxy adhesive where screws cannot or should not penetrate substrate.
- D. Include the following information on nameplates as applicable for equipment items:
  1. The equipment position identification number;

2. Manufacturer's name
3. Equipment model number and serial number;
4. Impeller size;
5. Date of manufacture;
6. For pump – rated flow capacity in gpm and rated total dynamic head in feet of fluid;
7. For pump – normal and max rotating speed
8. For motor - horsepower;
9. For motor - speed;
10. For motor - voltage;
11. For motor - amps;
12. For motor - power and service factors;
13. For belt drive - Input and output speeds, sheave and belt sizes; and
14. Other key information.

### **PART 3 EXECUTION**

#### **3.01 PRE-FABRICATION QUALITY CONTROL**

- A. Before base fabrication begins, Contractor shall visit the site to field verify base/frame dimensions and piping elevations to assure new pump base/frame will fit and elevations match existing piping system.

#### **3.02 DEMOLITION**

- A. By Others.

#### **3.03 INSTALLATION**

- A. Installation will be by Others, however, pump Manufacturer's representative shall support and verify proper installation.
- B. Pump and drive assembly will be precision aligned by a specially trained mechanic. Check angular and parallel alignment and adjust pump assembly so that the drive unit is properly aligned, plumb, and level to within 0.003 of an inch unless manufacturer's recommendation is greater. Eliminate any strain between attached piping and the pump, and correct evidence of pump or driver misalignment, noisy operation, or other signs of improper setting. Alignment shall be within those tolerances indicated below, unless manufacturer's tolerances are greater:
  1. Maximum allowable runout is 0.001 inches per inch of shaft diameter.
  2. Maximum allowable radial shaft deflection is 0.003 inches.
  3. Maximum allowable axial shaft deflection is 0.003 inches.

#### **3.04 FIELD INSPECTION AND TESTING**

- A. After completion of installation by Others, pump shall be completely tested to ensure compliance with operating and installation requirements.
- B. Provide the services of the pump Manufacturer's representative to operate the pumping unit. Pump test shall include monitoring of motor horsepower, discharge pressure and noise level.

- C. Installation contractor will test pump for proper rotation after wiring motor. Megger test motor and conductors to assure proper grounding and connections.
- D. Installation contractor will hydrostatically test piping and equipment with effluent for leaks at the maximum allowable working pressure of the pump. Leaks shall be fixed prior to final acceptance. Tighten fittings, replace gaskets, etc. to address the root cause of the leak.

3.05 MANUFACTURER’S FIELD SERVICES

- A. The Contractor shall furnish services of the equipment manufacturer's factory-trained representative(s) to insure that the equipment has been properly installed and is tested to provide continuous and satisfactory operation. The Contractor shall make, at his expense, all necessary changes, modifications, or adjustments required to assure satisfactory operation. The equipment manufacturer's representative shall also instruct the Owner's personnel in the maintenance and operation of the equipment. Operational training shall include instruction on field adjustment of rotor clearances. Maintenance training shall include complete disassembly and subsequent reassembly of the pump.
- B. The Contractor shall furnish the services of the equipment manufacturer’s representative to supervise installation, commission equipment and provide training to the Owner’s operations and maintenance personnel onsite.

Service Description	Minimum Number of hours onsite
Pre-fabrication site visit to field verify dimensions	-
Commission equipment during the operational testing phase and startup period. Includes functional testing and adjustments of the equipment	6
Operator and Mechanic Training	2

**END OF SECTION 11301**

## PART 1 GENERAL

### 1.01 WORK INCLUDED

- A. The work includes, but is not limited to, the following principal systems and equipment:
1. 120/208-Volt System.
  2. 480-System.
  3. Motors.
  4. Motor Control Centers.
  5. Panelboards.
  6. Conduit and Raceways, including underground.
  7. Transformers.
  8. Lighting fixtures and lamps.
  9. Grounding and Lightning Protection.
  10. Conductors.
  11. Miscellaneous Controls and Equipment.

### 1.02 REFERENCE STANDARDS

- A. Perform work, furnish and install materials and equipment in full accordance with the latest issue of the applicable rules, regulations, requirements, and specifications of the following:
1. Local laws and ordinances.
  2. State and Federal Laws.
  3. National Electrical Code (NEC).
  4. State Fire Marshal.
  5. Underwriters' Laboratories (UL).
  6. National Electrical Safety Code (NESC).
  7. American National Standards Institute (ANSI).
  8. National Electrical Manufacturer's Association (NEMA).
  9. National Electrical CONTRACTOR's Association (NECA) Standard of Installation.
  10. Institute of Electrical and Electronics Engineers (IEEE).
  11. Insulated Cable Engineers Association (ICEA).
  12. Occupational Safety and Health Act (OSHA).
  13. International Electrical Testing Association (NETA).
  14. American Society for Testing and Materials (ASTM).
  15. National Fire Protection Association (NFPA).
  16. American Concrete Institute (ACI).
  17. International Building Code (IBC).
  18. Insulated Power Cable Engineers Association (IPCEA).
  19. Association Edison Illuminating Company (AEIC).

- B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory.
- C. Product Quality: All electrical items shall be new and unused. Items such as cables, transformers, motors, control centers, etc., shall be newly manufactured for this project. Proof of purchase documents shall be provided upon request. Utilize products of a single Manufacturer for each item.

### 1.03 CONTRACT DOCUMENTS

- A. Intent:
  - 1. The intent of the contract drawings or Plans is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.
  - 2. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
  - 3. Install the work complete, including minor details necessary to perform the function indicated.
  - 4. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Engineer.
  - 5. It is also the intent of these Contract Documents for the electrical and process system Contractor to coordinate with each other in order to provide a complete and workable system with all wiring, conduit and accessories required which may not be shown on the Plans.
- B. Discrepancies:
  - 1. Review pertinent drawings and adjust the work to conditions shown.
  - 2. Where discrepancies occur between Plans, Specifications, and actual field conditions, immediately notify the Engineer in writing for his interpretation.
  - 3. Dimensions on electrical drawings shall be verified with structural, architectural and mechanical drawings.
- C. Outlet and Equipment Locations:
  - 1. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings.
  - 2. Review with the Engineer any proposed changes in outlet or equipment location.
  - 3. Relocation of outlets before installation, up to 10 feet from the position indicated, may be directed by Owner without additional cost.
  - 4. Remove and relocate outlets placed in an unsuitable location, when so requested by the Engineer.

### 1.04 REGULATIONS AND PERMITS

- A. Regulations: Work, materials and equipment must comply with the latest rules and regulations of the following:
  - 1. National Electrical Code (NEC).
  - 2. National Electrical Safety Code (NESC).

3. National Fire Protection Association (NFPA70E)
  4. Occupational Safety and Health Act (OSHA).
  5. State and federal codes, ordinances and regulations.
  6. Local Electrical Code.
- B. Discrepancies:
1. The Plans and Specifications are intended to comply with listed codes, ordinances, regulations and standards.
  2. Where discrepancies occur, immediately notify the Engineer in writing and ask for an interpretation.
  3. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation.
  4. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirement, provide those specified or shown.
- C. Permits: Obtain certificates of inspection and other permits required as a part of the work.

#### 1.05 CONTRACTOR QUALIFICATIONS

- A. An acceptable Contractor for the work under this division must have personnel with experience, training, and skill to provide a practical working system. The Contractor shall have previous water and wastewater experience with at least 5 years in business.
1. The Contractor shall be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project.
  2. The systems must have served satisfactorily for not less than 3 years.
  3. The superintendent must have had experience in installing not less than three systems.
  4. The Contractor shall submit qualifications of his firm and resumes of his personnel who will work on this project.
  5. Contractor shall have performed a minimum of three projects with the Owner.

#### 1.06 GENERAL REQUIREMENTS FOR WORKMANSHIP, EQUIPMENT AND MATERIALS

- A. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work by the local authority. (Licensed by the State of Texas)
- B. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing, or replacing any electrical wiring, apparatus, or equipment on any voltage level. A licensed Master Electrician or a licensed Journeyman Electrician holding a current license in the State of Texas is required to be on the job site during the performance of any electrical work. Master Electrician shall spend minimum of 2 hrs per week at the job site reviewing work completed.
- C. All cable splicing and termination methods and materials shall be of the type recommended by the splicing materials Manufacturer for the cable to be spliced, and shall be approved by the Engineer prior to installation.
- D. All materials and equipment shall be installed in accordance with the approved recommendations of the Manufacturer, the best practices of the trade, and in

conformance with the Contract Documents. The Contractor shall promptly notify the Owner in writing of any conflict between any requirements of the Contract Documents and Manufacturer's directions, and shall obtain written instructions from the Owner before proceeding with the work. Should the Contractor perform any work that does not comply with the Manufacturer's directions or such written instructions from the Owner, he shall bear all costs arising in correcting deficiencies.

- E. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the Manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard has been established for the particular item. Equipment shall be the latest approved design of a standard product of a Manufacturer regularly engaged in the production of the required type of equipment, and shall be supported by a service organization that is, in the opinion of the Owner, reasonably convenient to the site.
- F. It is the responsibility of the Contractor to insure that items furnished fit the space available with adequate room for proper operation and maintenance. He shall make measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that, in the final inspection, will suit the true intent and meaning of the Plans, Specifications and Contract Documents.
- G. The Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to complete the work, ready for use and operation by the Engineer/Owner.
- H. When the Engineer/Owner has reviewed equipment submittals and given instructions to proceed with the installation of items of equipment that require arrangements or connections different from those shown on the drawings, it shall be the responsibility of the Contractor to install the equipment to operate properly and in accordance with the intent of the Plans and Specifications, and he shall provide any additional equipment and materials that may be required. The Contractor shall be responsible for the proper location of roughing-in and connections by other trades. All changes shall be made at no increase in the Contract Amount or additional costs to other trades.
- I. The Contractor shall support the installation of all equipment, plumb, rigid and true to line. The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, and shall provide foundations, bolts, inserts, stands, hangers, brackets and accessories for proper support whether or not shown on the drawings.

#### 1.07 SHOP DRAWINGS AND PRODUCT DATA

- A. Data Required:
  - 1. Submit shop drawings, product data and all other required information as specified in Division 1. Submittals are required on all products and items to be installed on this project.
  - 2. Submittal data must show Manufacturer's name, published ratings or capacity data, detailed equipment drawing for fabricated items, panel diagrams, wiring diagrams, installation instructions and other pertinent data.

3. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated. Mark through items not being provided and clearly identify all options being provided.
  4. Do not combine submittal for multiple Specifications Sections.
- B. Submittal Items: Submittals are required for all equipment and materials to be used on this project. Submittals shall be complete with all pertinent information and installation details. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's Representative, and such procedures will not be cause for delay
- C. Terminal Connection Diagrams:
1. Submit terminal connection diagrams for approval prior to any wire installation.
  2. Submit finalized terminal connection diagrams at the end of the Contract.
  3. All Manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

#### 1.08 SYSTEM RESPONSIBILITY

- A. The Contractor shall be responsible for:
1. Complete systems in accordance with the intent of these Contract Documents.
  2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, Electrical.
  3. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
  4. Coordinate the work with the instrumentation Contractor.
    - a. The Instrument Contractor shall furnish and install the primary and secondary instruments.
    - b. The conduit and wiring to and from the instruments shall be furnished and installed by the Electrical Contractor. Termination in the instrument shall be by the Instrument Contractor.
    - c. All terminations in the control panel shall be by the Instrument Contractor.
    - d. The Electrical Contractor shall provide termination drawings for the instrumentation Contractor.
    - e. The equipment pad for the control panels, consoles and instrument panels shall be furnished by the Electrical Contractor.
    - f. The Electrical Contractor shall coordinate the testing of the electrical system being furnished. He shall be responsible for the equipment he is supplying.
    - g. The Electrical Contractor shall be present at the time of the instrument system testing and start-up. He shall be responsible to coordinate the testing of the facility with the Instrument Contractor, Engineer, and Owner.
    - h. The Electrical Contractor shall coordinate the interface requirement between each starter and control panel furnished under this Contract with the Instrument Contractor.

- B. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.
- C. Submit to the Engineer in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Submit such request as soon as practicable, and within ten (10) days after award of the Contract. Make no such departures without written approval of the Engineer.
- D. Dimensions on electrical drawings shall be verified with structural, architectural, and mechanical drawings.
- E. Where the Contractor is submitting a packaged system, Contractor shall meet the requirements of electrical specifications (16000). This includes field cables, conductors, labeling, relays, terminal blocks, conduits, junction boxes, circuit breakers, combination starters, pushbuttons, pilot lights, and motors. Deviations shall not be accepted, unless approved in writing in advance. Control centers and special control cabinets wired to terminal blocks shall include the Manufacturer's standard quality, unless specifically mentioned to the contrary on the drawings or in the specifications.
- F. Maintain continuity of electric service to functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with the Owner's designated Representative. Give the owner a minimum of one weeks notice prior to any shutdowns. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include costs for temporary wiring and overtime work required in the Contract price. Remove temporary wiring at the completion of the work. The Contractor shall be responsible to provide and pay for temporary power to any facility during construction to facilitate the new construction. If generator is needed Contractor shall be responsible for all the cost associated with, including fuel.
- G. Unless shown in detail, the drawings are diagrammatic and do not necessarily give exact details as to elevations and routing of raceways, nor do they show all offsets and fittings; nevertheless, install the raceway system to conform to the structural and mechanical conditions of the construction.
- H. Cabling inside equipment shall be carefully routed, trained, and laced. Placing cables so that they obstruct equipment devices is not acceptable.

## PART 2 PRODUCTS

### 2.01 PRODUCT REQUIREMENTS

- A. Condition: Materials and equipment provided under these Specifications must be new products of Manufacturers regularly engaged in production of such equipment. Provide the Manufacturer's latest standard design for the type of equipment specified.
- B. NEC and UL: Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products, and issued labels, products used must be listed and labeled by UL.
- C. NEMA and IEC: Only NEMA rated equipment is acceptable. IEC or dual rated NEMA/IEC equipment are not acceptable.

- D. Space Limitations: Equipment selected must conform to the buildings features and must be coordinated with them. Do not provide equipment that will not suit arrangement and space limitations.
- E. Factory Finish: Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required.
- F. Field Installation: All field installed equipment, conduit, etc., shall require Type 316 stainless steel nuts, bolts, washers, metal framing and supports, and other items as indicated on the Plans.
- G. Seismic Design: All electrical equipment to be designed in accordance with/IBC-2006 & ASCE 7-05 code for Seismic Design.

### PART 3 EXECUTION

#### 3.01 PROTECTION OF EQUIPMENT

- A. Moisture:
  - 1. During construction, provide heaters to protect switchgear, transformers, motors, control equipment, and other items from moisture absorption and corrosion.
  - 2. Apply protection immediately on receiving the products and provide continuous protection.
  - 3. Store all equipment indoors in dry, well ventilated and heated space.
- B. Clean: Keep products clean by elevating above ground or floor and by using suitable coverings.
- C. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- D. Finish: Protect factory finish from damage during construction operations and until final acceptance of the project.
- E. Protect Equipment per the Manufacturer's requirements.

#### 3.02 INSTALLATION

- A. Cooperation with Other Trades:
  - 1. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.
  - 2. Coordinate equipment layout in sufficient time to be coordinated with work of others, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
- B. Workmanship: Work must be performed by workmen skilled in their trade. The installation must be complete whether the work is concealed or exposed.
- C. Concrete Equipment Pads:

1. Install minimal 4-inch-thick concrete housekeeping pads with chamfered edges for indoor and outdoor floor mounted equipment.
2. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond indoor equipment.
3. Exterior pads shall extend one foot beyond the equipment, including cooling fins.
4. Trowel pads smooth and chamfer edges to a 1-inch bevel.
5. Provide dowels in slab, and rebar between the dowels.
6. Pads must drain away from the equipment.
7. Secure equipment to pads as recommended by the Manufacturer.
8. Follow structural detail where applicable.

D. Setting of Equipment:

1. Equipment must be leveled and set plumb.
2. Stainless Steel 316 enclosures mounted against a wall must be separated from the wall not less than 1/2-inch by means of corrosion resistant 316 Stainless Steel spacers or by 3- inches of air for freestanding units. Mount on shallow 316 Stainless Steel unistrut.
3. Stainless Steel 316 bolts, nuts and washers to anchor the equipment.

E. Sealing of Equipment:

1. Permanently seal outdoor equipment at the base using cocking and areas around conduits using grout.
2. Seal or screen openings into equipment to prevent entrance of animals, birds and insects.
3. Use stainless steel mesh with openings not larger than 1/16-inch squares for screened openings.
4. Seal small cracks and openings from the inside with silicone sealing compound.

F. Concealed Work: Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
2. Where exposure is necessary to the proper function.
3. Where size of materials and equipment precludes concealment.

### 3.03 TESTING

A. Test Conditions:

1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation.
2. Perform specified tests in the presence of the Engineer, as specified in Division 1 - General Provisions and 16 - Electrical.
3. Furnish all instruments, wiring, equipment, and personnel required for conducting tests. Engage the services of an independent contractor where required. Test equipment shall be calibrated within the last 6 months.
4. Demonstrate that the equipment operates in accordance with requirements of the plans and specifications.

5. No process equipment is to be operated until all associated HVAC equipment and auxiliary equipment is operational.

- B. Test Dates: Schedule final acceptance tests sufficiently in advance of the Contract completion date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the Contract.
- C. Retests: Conduct retests as directed by the Engineer of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of his responsibility under this contract. Provide notice to Engineer and Owner of testing 30-days prior to testing.

### 3.04 PROJECT RECORD DOCUMENTS

- A. Preparation:
  - 1. At the job site, maintain a set of white prints of the contract drawings.
  - 2. At the job site, maintain a set of equipment terminal connection diagrams.
  - 3. On the prints, record field changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings.
  - 4. Mark the drawings with a carmine red pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.
- B. Delivery: Deliver record drawings to the Engineer in the number and manner specified in Division 1 - General Requirements.

### 3.05 CUTTING AND PATCHING

- A. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of the Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition.

### 3.06 LOAD BALANCE

- A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, etc.

### 3.07 MOTOR ROTATION

- A. Before and after final service connections are made, check and correct as necessary the rotation of motors.
- B. Coordinate rotation checks with the Engineer and the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor verifying that rotation has been checked and corrected.

3.08 CLEANING AND TOUCH-UP PAINTING

- A. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides finish equal to or better than the factory finish, and that meets the requirements of the Specifications and is acceptable to the Engineer.
- B. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.
- C. All temporary wiring, wiring devices and associated equipment shall be removed upon completion of the project.

3.09 MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for work under the Division 16 Specifications. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

**PART 1: GENERAL****1.1 Description and Scope of Work**

This section specifies raceways, fittings, and supports for all cables, conductors and electrical equipment. The contractor shall furnish and install complete raceway systems in accordance with the following specifications.

**1.2 References**

<u>Code</u>	<u>Title</u>
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NFPA 70	National Electrical Code (NEC)
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<u>Standard</u>	<u>Title</u>
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NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
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ANSI C80.1	Rigid Aluminum Conduit and Rigid Galvanized Steel Conduit
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ANSI C80.4	Fittings and Supports for Conduit and Cable Assemblies
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NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC-40)
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NEMA TC3:	PVC Fittings for Use with Rigid PVC Conduit and Tubing.
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UL7 514B	Fittings for Conduits and Outlet Boxes
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UL 651:	Schedule 40 Rigid PVC Conduit
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**1.3 Submittals**

A. Submittals shall be made in accordance with the requirements of Section WW-01300, "Submittals".

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section WW-01730.

**PART 2: PRODUCT****2.1 Exposed-Outdoor Above Ground Level**

A. Rigid Aluminum Metal Conduit System

Conduit run above ground shall be U.L. listed 99 % copper free rigid aluminum and meet the requirements of ANSI C40.5. Conduit pipe straps and hardware to be 316 stainless steel. Conduit shall be manufactured by “Allied Company”, or approved equal.

**Minimum above grade conduit size for all work shall be 3/4-inch. Minimum underground conduit size for all work shall be one (1) inch.**

B. Conduit Seals

Conduit seals to be suitable for use in class-I, group B, C, and D, and class-II group F and G. Conduit seals shall also meet or exceed the following minimum requirements:

1. Seal body, nipples and closures shall be 99% copper-free aluminum. Seals bodies shall be filled with **3M 2123 Re-Enterable Sealing Compound**.
2. Drain: Stainless steel
3. Removable Nipples: 99% copper-free aluminum
4. Seals can be installed/removed without disassembling the conduit system.

Conduit seals to be manufactured by “Crouse-Hinds” type EYS drain seals with specified options, or approved equal.

Seals to be installed directly adjacent to, and, just immediately before entering wet well junction box. See details on drawings.

C. Conduit Hubs

Conduit hubs shall be the grounding type, 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by “Myers”, or approved equal. Conduit hubs shall be furnished complete with rubber gasket.

D. Grounding Bushings

Conduit grounding bushing shall be 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by Meyers type STAG, or approved equal.

E. Conduit Bodies

All conduit bodies shall be 99% copper-free aluminum. Conduit bodies shall be manufactured by “Crouse-Hinds” Form 7, or approved equal.

F. Conduit Body Covers

Conduit Body Covers shall be die cast aluminum with 316 stainless steel screws. Snap on covers are unacceptable. Supply gaskets with all covers.

G. Conduit Unions

Conduit unions shall be threaded, 99% copper-free aluminum. Conduit unions shall be manufactured by “Crouse-Hinds” type UNF or UNY, or approved equal by “Appleton” or “O.Z. Gedney”.

H. Clamp Backs

Single runs of conduit may be supported with cast aluminum clamp backs with stainless steel hardware and standoffs.

I. Conduit Straps

All conduit straps shall be 316 Stainless Steel unless indicated differently by the plans and or specifications.

**2.2 Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete**

Conduit run underground in duct bank system shall be schedule 40 PVC, U.L. rated, No. 651, conforming to NEMA standard TC-2-75 and listed in conformity with Article 347 of the national Electrical Code (NEC). The conduit is to be manufactured by “Carlson”, or approved equal. Solvent weld shall be a type approved by the conduit manufacturer.

The transition point from underground duct bank to above ground raceway system shall be made utilizing PVC coated rigid galvanized steel (RGS) conduit. PVC coated RGS conduit shall be coated with a 40 mil exterior coating of PVC and a 2 mil urethane interior coating. The coating system shall be in compliance with ETL PVC-001. Refer to Part 3-Execution of this Section, and to details provided on the contract drawings. PVC Coated Rigid Galvanized Steel conduit shall be Plasti-Bond REDH2OT or Perma-Cote coated conduit as manufactured by Rob Roy. A manufacturer’s installer certification shall be required for electricians installing the PVC coated RGS conduits.

The minimum depth of a duct bank is 24” to the top of the Concrete.

**Minimum conduit size for all underground work shall be 1-inch.**

### **2.3 Liquid Tight Flexible Conduit**

Liquid tight flexible conduit shall be non-metallic (NM) type liquid tight flex for sizes ¾" through 2". For sizes 2 ½" and larger provide standard seal tight flex with aluminum core, formed from PVC plastic. Provide aluminum or nonmetallic liquid tight fittings that are suitable for installation in temperature range between -20 degrees C to +60 degrees C (suitable for use outdoors and indoors). Liquid tight flexible conduit and fittings shall be as manufactured by "Electri-Flex" series NM type B-PVC, Thomas & Betts type LT-38P, or approved equal. ½" type NM flexible liquid tight conduit may be used for instruments having ½" threaded entry point.

Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and, where shown on the drawings. Maximum length to be 36" unless otherwise noted on drawings or approved by the owner or engineer.

### **2.4 Electrical Equipment and Raceways Support Channels**

Electrical equipment and raceway support channels shall be fabricated with 316 stainless steel material manufactured by "Unistrut Corporation" series P-1000SS and P-1001SS, or approved equal. All fastening hardware, fittings, supports, base posts, clamps, framing system, etc. shall also be fabricated with 316 stainless steel. Manufacturer shall be "Unistrut Corporation," or approved equal.

## **PART 3: EXECUTION**

### **3.1 General**

Install electrical equipment and raceway system conduit in accordance with the recommendations of the manufacturer, the requirements of the National Electrical Code, local codes, and the contract drawings and these specifications.

Use only persons skilled and licensed in the state of Texas to perform this type of work.

### **3.2 Conduit System**

A. Install Schedule 40 PVC conduit underground in reinforced duct banks changing to PVC coated rigid galvanized steel conduit at the final factory 90 degree bend, transitioning from underground to the above ground conduit system. The transition from PVC coated

## RACEWAYS, FITTINGS, AND SUPPORTS

- RGS to aluminum rigid shall be made at a minimum of 6" above the ground, finished slab, and/or housekeeping pad. Duct banks and/or conduit banks shall remain reinforced (along the entire length utilizing stirrups on a minimum of 2'-0" spacing and chairs at a 5'-0" spacing), encased in red concrete to its final destination even when routed under building/structure, concrete floor slab, and/or equipment concrete/housekeeping concrete pad. Rebar shall be kept a minimum of 2" off of the ground to allow complete concrete coverage. There shall be a minimum cover of 24" to the top of concrete for all duct banks. Concrete shall be 3000 psi. A red add mixture, HBS #120 Conduit Red as manufactured by ChemSystems, Inc., or equal, shall be added to the concrete at a minimum of 12 pounds per cubic yard of concrete. Forms shall be used except that side forms are not necessary where the earth is firm enough to support the concrete.
- B. Run exposed conduit parallel or at right angles to building lines.
  - C. Secure conduits to all cabinets and boxes with specified hubs and bonding jumpers in such a manner that each system is electrically continuous throughout.
  - D. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed and swabbed clean immediately before wiring is pulled in.
  - E. Cap conduits during construction to prevent entrance of dirt, trash, and water.
  - F. Equip conduit across structural joints, where structural movement is allowed with an O.Z./Gedney, or equal, 99 % aluminum expansion fittings of that conduit size.
  - G. Conduit nipples shall have two independent sets of threads. Running threads shall not be used. Where conditions require joining two fixed conduits into a continuous run, a conduit union shall be used.
  - H. Coat all conduit threads with a Noalox, Penetrox, or approved equal.
  - I. Provide a minimum of 2-inches separation utilizing Plastic conduit chairs between conduits installed in concrete duct bank. Spacing may be less at panel boards, pull or junction boxes or other locations where the conduits have to be grouped.
  - J. Conduit Penetrations:
    - 1. Use 3M 20mil corrosion tape to protect raceways for penetrations through walls, floors, and block outs and grout once work is complete. The tape should extend 6" beyond the walls or floors.
    - 2. **Link-Seal** modular seals shall be used for all subgrade conduit penetrations.
    - 3. **PVC** pipe shall be used for all pour-in-place concrete conduit penetrations.

- K. Maintain 6” clearance between conduit and piping and 12” clearance between conduit and heat sources such as flues, steam pipes and heating appliances.
- L. Arrange conduits to maintain headroom and present a neat appearance.
- M. Conduits run above ground shall be supported at least every 10 feet and once in every change in direction and at the end of each straight run terminating in an enclosure and within three feet of every junction box.
- N. Secure conduit runs firmly to specified support channels by stainless steel conduit straps or by hangers, as required.
- O. Top of duct bank shall be installed a minimum of 24 inches below grade and shall slope 3 inches per 100 feet from high points toward the manholes.
- P. All underground conduit joints shall be waterproofed in accordance with the manufacturer’s recommendations
- Q. Rigid conduit joints to be cut square, threaded, reamed smooth and drawn up tight. Bends or offsets to be made with standard conduit ells. Make field bends with an approved bender or hickey or hub type conduit fittings. Conduit shall contain no more than the equivalent or three (3) 90 degree bends between outlets or fittings.
- R. Backfilling shall be done in such a manner that voids will be minimized. Tamp backfill so that it is the same density as the surrounding soil. Excess soil shall be piled on top and shall be well tamped. All rock and debris shall be removed from the site.
- S. Conduits joints to be staggered a minimum of 6”.
- T. Where a duct bank penetrates or turns up next to a structure, dowel rebar a minimum of 4” into the structure at the point of connection/intersection tying the steel reinforcing of the duct bank to the structure at a minimum of four locations.
- U. All duct banks shall be placed under building slab (not in building slab) with longitudinal duct bank steel reinforcement tied to building slab steel reinforcement with an 18-inch overlap.
- V. Conduits shall penetrate building slab at 90 degrees and shall run in duct banks under building slab and **not** run parallel though building slabs.

### 3.3 Installation of Support Channels

- A. Utilize 316 stainless steel support channels to install raceways, and any other surface mounted electrical, instrumentation and control equipment. Refer to details shown on the contract drawings.

- B. All mounting hardware and straps shall be 316 stainless steel.

## PART 1 GENERAL

### 1.01 WORK INCLUDED

- A. **Equipment:** This section specifies general requirements for fractional and integral horsepower electric motors 200hp and below with a voltage rating of 480VAC or below. Unless otherwise specified, provide motors meeting the basic requirements for high efficiency premium insulation general-purpose alternating current motors, as defined in NEMA MG 1.
- B. **Unit Responsibility:** Motors shall be furnished under other sections of this specification as a part of the driven equipment. The contractor is responsible for all coordination between the various components, as well as for the warranty.
- C. **Exceptions:** Exceptions to this section are listed in the various sections that specify motor-driven equipment or are indicated on the drawings.
- D. Motors connected to variable frequency drives shall be inverter duty rated; each bearing on the non-drive end shall be insulated.
- E. This specification does not cover Submersible Motors.

### 1.02 REFERENCE STANDARDS

- A. The following standards shall apply as if written here in their entirety:
  - 1. ANSI/NEMA MG1 - Motors and Generators.
  - 2. ANSI/UL 674(A) - Safety Standard for Electric Motors and Generators for Use in Hazardous Locations, Class II, Groups E, F and G.
  - 3. ANSI/UL 674(B) - Safety Standard for Electric Motors and Generators for Use in Hazardous Locations, Class I, Groups C and D.
  - 4. NFPA 70 - National Electrical Code (latest Edition).
  - 5. IEEE 112 - Standard Test Procedure for polyphase induction motors and generators.
  - 6. UL 1004 - Electric Motors.

### 1.03 WARRANTY

- A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components that fails in materials or workmanship within specified warranty period. The warranty period shall start at substantial completion.
- B. **Warranty Period:** No less than the driven equipment warranty.

### 1.04 SUBMITTALS

- A. **Requirements:** Refer to, Division 1 and Division 16 and to the specific driven equipment sections.

- B. Information: Include the following information on the attached motor data sheet.
1. Manufacturer.
  2. Rated full load horsepower and speed.
  3. Rated volts at 60 Hz.
  4. Number of phases at 60 Hz.
  5. Frequency in hertz.
  6. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
  7. NEMA design letter.
  8. Bearing Type.
  9. Service Factor.
  10. Nominal speed at full load.
  11. Full Load Amperes (FLA)
  12. Efficiency at 1/2, 3/4 and full load.
  13. Power factor at no load, 1/2, 3/4 and full load.
  14. NEMA insulation system classification. For motors installed outdoors, include information showing compliance with the intent of paragraph 2.3D.
  15. Corrosion duty rating
  16. Fan, end bell cast evidence.
- C. Integral Horsepower Motors 40HP and Larger: In addition to the information listed above, include:
1. No load amperes.
  2. Safe stall time.
  3. Maximum guaranteed slip at full load.
  4. Motor damage curves for motors larger than 100HP.
  5. Motor manufacturer recommended maximum power factor correction capacitor KVAR for a power factor of 0.95.
- D. Include the motor data sheet at the end of this section in submittal.
- E. The motor manufacturer shall provide in writing that he has coordinated the motor data with VFD and or RVSS manufacturer and that the motor is suitable for VFD or RVSS application.
- F. Submit a letter showing all the exceptions to the specification. If no exceptions are taken, the letter shall indicate no exceptions. Submittal will be rejected without preliminary review if the letter is not submitted.

## PART 2 PRODUCTS

### 2.01 RATING

- A. Speed and Size:
1. Speed and horsepower sizes are specified in the driven equipment specification sections or are indicated on the drawings.
  2. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity.
  3. Size motors so as not to overload at any point throughout the normal operating range.

4. Furnish dual speed motors of two speed, two winding type, when specified.

- B. Frequency: 60 hertz.
- C. Service Factor: 1.15 for all motors.

#### 2.02 DESIGN TYPE

- A. Motors Smaller Than 1/6 Horsepower: Provide single-phase 120 volts, induction motors with integral thermal protectors.
- B. Motors 1/6 Through 1/2 Horsepower: Provide single-phase 120 volts, NEMA Design N, induction motors.
- C. Motors Larger Than 1/2 Horsepower: Provide 3-phase, 480 volts NEMA Design B, induction motors unless specified otherwise.
- D. Acceleration NEMA Time: If the calculated acceleration time of the combined motor and driven load exceeds 3 seconds at 90 percent of rated voltage, request review by the Engineer. Do not proceed with manufacturing without approval.
- E. All induction motors shall have squirrel cage rotors.
- F. Motor shall be suitable for outdoor environment.

#### 2.03 MOTOR INSULATION AND WINDING

- A. Class: Use a Class F insulation with temperature Rise of Class B or better above 40° C ambient at 1.15 service factor, meeting the requirements of NEMA MG 1 section 12.40.2 and made of non-hygroscopic materials. The insulation shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock for 480-volt motors.
- B. All stator winding conductors shall be copper.
- C. Insulation for inverter duty motor shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be damaged when exposed to repeated pulse type wave forms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. All bearings on the non-drive end shall be insulated.
- D. Outdoor Suitability, all motors must be suitable for outdoor installation.

#### 2.04 ROTOR

- A. Motor shall have aluminum bar rotor fabrication/construction.

#### 2.05 GROUNDING CONNECTIONS

- A. Ground provisions shall be furnished per NEMA STANDARD.

- B. For motors less than 1/6 HP, each motor shall be furnished with provision for attaching a ground connection to the motor frame inside the motor terminal housing.

## 2.06 LEADS

- A. For motor leads, use not less than ASTM B 173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph.
- B. Provide permanent identification numbers on leads according to NEMA MG.
- C. Use crimp-on, solderless tinned copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals for motors 1/2 Hp and below. Terminations on motors 1/2 Hp and larger to be made with Polaris Block type connectors.
- D. Or approved equal.

## 2.07 ENCLOSURE

- A. Use enclosure type as follows:
  1. Indoors: Totally enclosed, fan cooled (TEFC).
  2. Outdoors: Totally enclosed, fan cooled (TEFC), weatherproof.
  3. Class 1 Division 2 Area: Provide motors totally enclosed, non vented, explosion proof (TEFC-XP).
  4. Class 1 Division 1 Area: Provide motors rated for this class.
  5. Motors mounted vertically shall be provided with the rain/snow shield made of the same material as the motor frame.
  6. Motors shall have drain openings and plugs suitably located for the type assembly being provided.
  7. Motor shall be corrosion resistant and severe duty rated per IEEE 841.
- B. TEFC motors shall have a cast iron frame, cast iron end brackets, cast iron bell frame, cast iron conduit box, tapped drain holes (erosion resistant plug for frames 286T(20HP) and smaller and automatic breaker/drain devices for frame 324T(25HP) and larger, and upgraded insulation by additional dips and baked to increase moisture resistance.

## 2.08 BEARINGS

- A. Motors smaller than 1/6 Horsepower: Motor manufacturer's standard bearing is acceptable.
- B. Motors 1/6 Horsepower and Larger: Supply these motors with grease-lubricated antifriction ball bearings conservatively rated for 60,000 hours L10 minimum life of continuous operation under the total radial and thrust loads produced by the actual combination of motor-driven equipment. Provide each motor with suitable lubrication fittings and pressure relief devices.

- C. Oil Lubricated: If the driven equipment section specifies oil-lubricated bearings for motors, include a suitable sight gauge on each bearing with maximum and minimum levels clearly indicated.
- D. Unless specified otherwise in the driven equipment specifications. Motor bearing life shall be 60,000 hours L10 minimum life whichever is greater.

#### 2.09 NAMEPLATES

- A. Main Nameplate: Provide each motor with a stainless steel nameplate meeting the requirements of NEMA MG, and the National Electrical Code, Section 430-7.
- B. Heater Nameplate: When space heaters are furnished, include voltage and wattage on a suitable nameplate.
- C. Bearings Nameplate: When bearings are oil lubricated, include oil type information on a suitable nameplate. Also, indicate bearing data if nonstandard.
- D. Attachment: Attach the nameplates to the motor with stainless steel fastening pins or screws.

#### 2.10 IDENTIFICATIONS:

- A. All motors shall be identified as shown on drawings.

#### 2.11 CONDUIT BOX

- A. Provide each motor with a conduit box amply dimensioned for the motor lead terminations. Include a grounding lug on motors 1/6 horsepower and larger. Supply a gasket suitable for the motor enclosure type and application.
- B. Provide an oversize box to facilitate wiring terminations. Provide Polaris block type connectors for motors 1/2 Hp and above.
- C. Oversized terminal box shall have a volume greater than or equal to the next standard NEMA size box.
- D. Terminals shall be tinned copper.
- E. Every motor provided shall be hardwired. No motor shall be provided with a cord and a plug.

#### 2.12 SPACE HEATERS

- A. Provide space heaters in all motors 25HP and above.
  - 1. Use heaters hermetically sealed in stainless steel or equivalent corrosion-resistant sheaths.
  - 2. Heaters shall be rated for 240V, but will be operated at 120 volts.
  - 3. Braze heat-resistant insulated leads to the heater or supply heater with brazed leads and extend to the conduit box.

### 2.13 MONITORING DEVICES

- A. Motor shall be protected and be supply with necessary monitoring devices per driven equipment specification and contract drawing.

### 2.14 PAINT

- A. Shall be severe duty and shall have an epoxy coating per IEEE 841.

### 2.15 ACCEPTABLE MANUFACTURERS

- A. The motor model shall be as listed and manufactured by one or more of the following manufacturers unless otherwise approved by the Engineer.
  1. General Electric.
  2. TECO/Westinghouse
  3. US Motors.

### 2.16 MOTOR EFFICIENCIES

- A. Three phase motors rated 1 Hp and larger shall be of the NEMA premium efficiency type. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.
- B. Motor shall be severe duty rated for industrial application.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. The Contractor shall make all electrical connections to equipment specified. Installation shall be made in compliance with manufacturer's recommendations and the Contract Drawings. If the Contract Drawings or drawings and recommendations from the Manufacturer are not available then installation shall proceed according to the best electrical industry and trade practice.
- B. Properly install and align motors in the locations shown, except motors which are factory mounted on the driven equipment. When the motor and equipment are installed, the nameplate must be in full view.

### 3.02 LARGER MOTORS

- A. If a motor horsepower rating larger than indicated is offered as a substitute and accepted, provide required changes in conductors, motor controllers, overload relays, fuses, breakers, switches and other related items with no change in the contract price.

### 3.03 TESTING

- A. General: Provide all necessary instruments, labor and personnel required to perform motor inspection and testing.

- B. Inspection: Inspect all motors for damage, moisture, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification and cleanliness, and report any abnormalities to Engineer before energizing.
- C. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads in motor controllers properly rated and all controls in place, energize the equipment at system voltage for operational testing.
- D. As a part of the testing procedure, the Contractor shall prepare a card for each motor, 20 HP and larger, installed on this contract. After each motor has been run to operating temperature, the motor shall be shut down and an insulation resistance shall be made, using a megohmmeter. Make the test immediately after shutdown. Record megohmmeter reading and winding temperature. Correct reading of insulation resistance to 40° C/104°F. Insulation resistance in megohms, corrected to 40° C, shall be at least equal to one (1) megohm for each 1000 volts applied.
- E. Testing shall be in accordance with Division 16.

**ELECTRIC MOTOR QUESTIONNAIRE**  
**Motor Data**

Manufacturer: \_\_\_\_\_ Motor HP: \_\_\_\_\_  
Frame \_\_\_\_\_ Enclosure: \_\_\_\_\_  
Type: \_\_\_\_\_ RPM: \_\_\_\_\_  
Voltage: \_\_\_\_\_ Phases: \_\_\_\_\_ Hertz: \_\_\_\_\_  
Starting Method: \_\_\_\_\_  
Shaft: Size: \_\_\_\_\_  
Insulation Class: \_\_\_\_\_ Duty: \_\_\_\_\_

Full Load AMPS: \_\_\_\_\_ No Load AMPS: \_\_\_\_\_  
Locked Rotor AMPS: \_\_\_\_\_ Locked Rotor Time: \_\_\_\_\_  
Locked Rotor Torque: \_\_\_\_\_ % Breakdown Torque: \_\_\_\_\_  
Locked Rotor KVA/HP: \_\_\_\_\_ Rotor WK2 (lb-ft<sup>2</sup>): \_\_\_\_\_

NEMA Design: \_\_\_\_\_ Service Factor: \_\_\_\_\_ Inrush Current (% of Full Load): \_\_\_\_\_

Max Safe Stalled Time (Seconds): \_\_\_\_\_

Number of Safe Starts Per Day: \_\_\_\_\_ Number of Consecutive Starts: \_\_\_\_\_

\*Full Load Temp Rise, degrees C over 40° C Ambient (at 1.0 S.F.): \_\_\_\_\_

\*Service Factor Temp Rise, degrees C over 40° C Ambient (at 1.15 S.F.): \_\_\_\_\_

\*Limiting Temperature Rise: \_\_\_\_\_

Resistance (at 25° C): \_\_\_\_\_

Bearings: Type/Size \_\_\_\_\_ Life \_\_\_\_\_ Lubrication: \_\_\_\_\_

Exhaust Air (CFM): \_\_\_\_\_ Exhaust Air Temp Rise (°F): \_\_\_\_\_

	<u>EFFICIENCY:</u>	<u>POWER FACTOR:</u>	<u>CURRENT</u>
1.15 S.F. Load:	_____	_____	_____
4/4 Load:	_____	_____	_____
3/4 Load:	_____	_____	_____
1/2 Load:	_____	_____	_____
1/4 Load:	_____	_____	_____

\*Temperature rise measured by embedded detectors and not by resistance.

All Data Fields To Be Completed By The Motor Manufacturer

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

### 1.02 REFERENCE STANDARDS

- A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Division 16.

### 1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.
- B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Control Stations
  1. Control stations shall be heavy-duty type, with full size operators. Momentary contact stop buttons shall have a lockout latch that can be padlocked in the open position. Provide an extra contact to monitor the auto position of the switch as shown on the drawings.
  2. NEMA 4X enclosures shall be stainless steel.
  3. NEMA 7 enclosures shall be copper free cast aluminum.
  4. Control stations shall be Allen-Bradley or approved equal.
- B. Wireway
  1. NEMA 4X wireway shall be stainless steel with gasketed, hinged covers and stainless steel type 316 screws.
  2. NEMA 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co. or approved equal.
- C. Control relays
  1. Control relays shall have 120-volt coils, 11 pin tubular octal bases with indicating light, and contacts rated for 10 amps. Furnish 1 N.O. and 1 N.C. spare contacts in addition to those required by the control scheme.
- D. Timing relays

1. Timing relays shall have 120 volt coils, 11 pin base, selectable for on delay or off delay functions, and settable for time delays of 0.05 seconds to 999 minutes with 10 amp contact rating. Relays shall be Square D class 9050 type JCK70 or equal.
- E. Polyethylene Warning Tape
1. Warning tape shall be red metal detectable polyester, 6-in minimum width.
  2. Warning tape legend shall read: "CAUTION: BURIED ELECTRIC LINE BELOW".
- F. Terminal Blocks
1. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.
  2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co. or approved equal.
- G. JIC Boxes for GF Receptacles
1. Furnish all necessary hardware for mounting the heat tape and thermostat.
  2. JIC boxes shall be 6-in by 6-in by 4-in aluminum continuous hinge clamp cover boxes, Hoffman, Catalog No. A-606 CHAL with Type L23 stainless steel type 316 fast operating JIC clamp or approved equal.
  3. Install 1-1/2-in bushings in bottom of box for cord and plug to pass through.
- H. Corrosion Inhibitors
1. All equipment enclosures, terminal boxes, etc, located in a NEMA 4X rated area (where shown on the Drawings) that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.
  2. The corrosion inhibitor pads shall be as manufactured by Hoffman Engineering Co.; 3M or approved equal.
- I. Instrumentation Disconnect Switches: Provide a heavy-duty single pole disconnect toggle switch in a weather proof cast enclosure for all field instruments served with electric power. This feature shall be included whether or not shown on drawings.
- J. Fuses, 0 to 600 Volts: Provide a complete set of current-limiting fuses wherever fuses are indicated. Supply a set of six (6) spare fuses of each type and each current rating installed. Utilize fuses that fit mounting specified:
1. For 0 to 600 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1 with time delay, Bussmann Type LPS-RK, Shawmut Type A6D-R, or equal.
  2. For 0 to 250 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1, Bussmann Type LPN-RK, Shawmut type A2D-R, or equal.
  3. For 0 to 600 volt feeder and service circuits, 0 to 600 amps, UL Class RK-1, Bussmann Type KTS-R, Shawmut Type A6K-R, or equal.
  4. For 0 to 250 volt feeder and service circuits, 0 to 600 amps, UL Class Rd-1, Bussmann Type KTN-R, Shawmut Type A2K-R, or equal.
  5. For 0 to 600 volt feeder and service circuits, 601 to 6,000 amps, UL Class L, Bussmann type KRP-C, Shawmut Type A4BY, or equal.

- K. Indicating Lights: Indicator lamps shall be heavy duty 30mm, industrial type oil tight, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Unless otherwise specified in each equipment specification lens color shall be green for equipment OFF, red for equipment operating, amber for FAIL and white for power ON/Equipment Stand-by. For all control applications, indicator lamps shall incorporate a push-to-test feature.
- L. Selector Switches: Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30mm, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.
- M. Push Buttons: Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Button color shall be red for or START and green for STOP. Contact arrangement shall be as required.
- N. E-stop push button: Emergency stop push-button shall be red, non illuminated, mushroom type heavy duty, industrial type with maintained contact, rated for 120 VAC at 10 Amps continuous. Button shall Cutler Hammer HT800 or approved equal.
- O. Combination starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Combination Starter is applicable for single motor starter only, refer to common control panel specification for other application.
  - 1. Motor starters shall be 2 or 3 Pole, 1 or 3-phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing except as shown on the drawings. NEMA sizes shall be as required for the horse power shown on the drawings.
  - 2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the drawings. A minimum of one N.O. and N.C. auxiliary contacts shall be provided in addition to the contacts shown on the drawings.
  - 3. Overload relays shall be adjustable ambient compensated and manually reset.
  - 4. Control power transformers shall be sized for additional load where required. Transformer primaries shall be equipped with time-delay fuses.
  - 5. Switches, relays, push buttons shall be as specified under this section.
  - 6. Provide additional protection as shown on contract drawing.
  - 7. Enclosure shall be Nema 4X for outdoor application and Nema 12 for indoor application.
- P. Lighting Contactor
  - 1. Lighting contactor shall be of the electrically operated, mechanically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings)

with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand-Off-Auto" switch on cover where shown on the Drawings.

2. Contactors shall be rated for 20 Amps, 600 VAC and shall be Automatic Switch Co., Bulletin 917 RC, similar by Square D Co.; Cutler Hammer/Westinghouse or approved equal.

Q. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings.
2. 120V Photocell shall be Precision P2275 or approved equal.
3. Locking type receptacle shall be Precision M2A or approved equal.

R. Intrusion Switch: Surface mount aluminum housing contract with armored cable Model 2507 ADL or approved equal

PART 3 EXECUTION - NOT USED

END OF SECTION

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. Provide, furnish and install all **electrical wire/s, conductor/s and cable/s (WCC)** for all electrical, instrumentation and controls (EIC) work , as applicable and required, to make all electrical system/s complete and satisfactorily operable as specified here-in and designated per the Contract PLANS. Coordinate WCC accordingly for instrumentation and controls (I&C) requirements and applications.
- B. All WCC work shall comply per the National Electrical Code (NEC), all applicable federal, state, and local codes, regulations and ordinances.

**1.02 RELATED SPECIFICATIONS**

- A. DIVISION 16 – Electrical
- B. DIVISION 17 – Process Instrumentation and Controls System, PICS
- C. ALL PROCESS AND/OR MECHANICAL PACKAGED SYSTEM/s --having electrical, instrumentation and control system/s, WCC, components, devices, etc. Reference all applicable and respective, related packaged system/s specification section/s, accordingly.
- D. Other related work as may be designated, required, and/or called for per the CONTRACT DRAWINGS, other related TECHNICAL / EQUIPMENT SPECIFICATIONS and/ or as elsewhere defined or designated.

**1.03 REFERENCES AND STANDARDS**

- A. References and Standards apply in their entirety:
  1. NFPA 70                      National Electric Code
  2. U.L. 44                      Thermoset-Insulated Wires and Cables
  3. U.L. 510                     Polyvinyl chloride, polyethylene, and rubber insulated tape
  4. U.L. 1685                    Vertical Tray Fire Propagation and Smoke-Release test for electrical and fiber optic cables
  5. IECA S-95 /                 Power Cables rated 2000V or less for distribution of electrical  
NECA WC-70                 energy
  6. ASTM B8                     Standard Specification for concentric-lay, stranded copper conductors --hard, medium-hard, and soft
  7. OWNER's Conductor Color Code standard --as designated here-in, 16200, 1.05 D.

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW****1.04 SUBMITTALS**

- A. Submittal/s per product information –catalog data sheets, product ratings, etc. per requirements and compliance per Division 1 – General Provisions, Section 01300, “Submittals”.
- B. Operations and Maintenance (O&M) Manuals –include all approved WCC submittals in the CONTRACT O&M per Section 01730.

**1.05 WIRES, CONDUCTORS AND CABLES COLOR CODING**

- A. Multi-conductor I&C cable/s: Color coding is specified in the multi-conductor cable type specification--as designated per the multi-conductor cable manufacturer.
- B. Power and control WCC: provide single conductor/s with integral insulation pigmentation of the designated and/or required color. EXCEPTION: conductor/s larger than No.6 may be provided with color coding by wrapping black color conductor/s at each end and at all accessible locations with respective/required colored vinyl tape. Where this method of color-coding is used, wrap at least six full overlapping turns of colored vinyl tape around the black color conductor/s covering an area 1-1/2 to 2 inches wide at a visible location.
- C. Phase A, B, and C implies the direction of positive phase rotation for AC power voltage.
- D. Implement OWNER’s authorized conductor color code as designated below:
1. Electric Power WCC compliance per COA, Austin Energy Utility

<u>System voltage/s</u>	<u>Conductor</u>	<u>Conductor Color</u>
a. All systems	Ground	Green
b. 120/240 volts, 1-phase, 3-wire	Hot Leg, L1	Red
	Other Hot Leg, L2	Black
	Neutral, grounded	White
c. 120/208 volts, 3-phase, 4-wire	Phase A	Red
	Phase B	Black
	Phase C	Blue
	Neutral, grounded	White
d. 277/480 volts 3-phase, 3-wire *	Phase A	Brown
	Phase	Yellow
	Phase C	Purple
	Neutral, grounded *	Gray *

\* 3-phase, 4-wire service drop from the power company; neutral is pulled and grounded at first main disconnect only; neutral conductor shall not be installed in electrical power distribution system -- **thereby standard**

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

**practice does not utilize 277V, 1-phase power (line to neutral)**

e.	Motor space heater/s @ 120 volts, 1-phase wrapped	Hot Leg Neutral	Black Black-  w/ white color vinyl tape
f.	DC circuit installed in raceway	Positive (+) Negative (-)	Blue Brown

2. Control Panel WCC shall be rated 41 strand, **tinned copper**, 600V insulation -- rated Type SIS --- WCC color code as follows:

a.	AC controls wire	Red
b.	Annunciator contacts	Yellow
c.	DC controls	Blue
d.	DC (+) power	Red
e.	DC (-) power	Black
f.	AC Hot	Black
g.	AC Neutral	White
h.	PLC/RTU discrete I/O's	Purple

E. NOTE: All WCC shall be color coded and tagged compliance per COA, AWU standard per section 16205 "Wire and Cable Tagging".

**PART 2 PRODUCTS****2.01 GENERAL**

1. Use the manufacturer's name, model or catalog number, if for purpose of establishing standard quality and general configuration desired only.
2. Splices are not approved --exception at lighting fixture/s and convenience receptacles.
3. Samples of all WCC shall be submitted when so requested by the ENGINEER/OWNER for the purpose of determining acceptability of the wire. WCC which have been rejected shall not be used at all. Such rejected WCC shall be removed from OWNER's premises.
4. Multi-conductors cable are NOT APPROVED.

**2.02 CONDUCTORS – 1000 VOLTS (1000V)**

1. Single Conductors at 600V insulation rating:
  1. Unless noted elsewhere or otherwise designated, all power and control WCC shall be 98% conductivity, soft annealed, stranded **copper** with 1000V insulation -- rated Type XHHW-2. Grounding WCC shall be bare, hard annealed, stranded copper.
  2. Use only WCC meeting applicable requirement per UL 44, UL 1685 and IECA S-95-658 (NEMA WC70).

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

3. Power WCC shall not be smaller than #12 AWG, unless otherwise noted on the Contract PLANS.
  4. Control WCC shall not be smaller than #14 AWG, unless otherwise note on the Contract PLANS.
  5. WCC shall be marked every two (2'-0") with the size, type and voltage rating as well as the Manufacturer's name and measurement markers.
  6. Unless otherwise note, conductor size/ampacity rating indicated are based on copper conductor. Do not provide conductor smaller than that designated -- comply per N.E.C.
  7. Approved WCC manufacturers: Anaconda, Cyprus (Rome), General Electric, the Okonite Company, Triangle, or approved equal.
  8. Where flexible power/power and controls cords and cables are supplied, provide same per Type SEOOW rated -- flexible stranded copper conductor/s, 600V insulation rating --with quantity and size conductors as required and/or where designated per the CONTRACT PLANS.
- B. Single Pair Instrumentation Cable – #16 AWG, stranded, twisted, shielded pair (2), 98% conductivity **copper** conductors, 600V insulation and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% pair conductors coverage -- rated Type TC Cable
1. Single pair instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Shall be rated for cable tray, conduit and/or other approved raceway. Minimum temperature rating shall be 90°C dry locations, 75°C wet locations.
- C. Single Triad Instrumentation Cable – #16 AWG, stranded, twisted, shielded triad (3) **copper** conductors, 600V insulation, and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% triad conductors coverage -- rated Type TC Cable
1. Single triad instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Suitable for installation in cable tray/s, conduit and/or other approved raceway/s. Minimum temperature rating shall be 90°C dry locations, 75°C wet locations.
- D. Equipment Grounding Wire/Conductor:
1. Provide stranded, copper conductor/s as designated, shown and required per N.E.C. for electrical system grounding and equipment grounding.
  2. Provide conductor/s with green color, 1000V insulation, minimum thickness of 1/32 inch -- rated Type XHHW-2.
- E. All control panel wiring shall be flexible, 41 strand, tinned copper, 600V insulation, Type SIS -- not smaller than #14 AWG, color coded as outlined here-in per section 16200, 1.05, D.2.

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

- F. All WCC shall be new, unused, in good condition and shall be delivered in standard coils, packages or reels. If wire used is different than what is specified, samples of wire shall be submitted for the purpose of determining acceptability of the wire. Wire which has been rejected shall not be used again. Such rejected wire shall be removed from the Owner's premises. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner or his representative.
- G. Power conductors shall not be smaller than No. 12 AWG, except for control and alarm wiring where No. 14 AWG shall be used as minimum size wire when protected by a 15 amp fuse/circuit breaker.
- H. The contractor may, if he deems it necessary or advisable, use larger sized conductors than those required. In no case shall there be a voltage drop greater than that allowed by the N.E.C.
- I. Multi-conductors cable are NOT APPROVED.
- J. WCC splice/s are NOT APPROVED, except for light fixtures and receptacles wiring.

**PART 3 EXECUTION****3.01 GENERAL**

- A. Do not exceed WCC manufacturer's recommendations for maximum pulling tension and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with WCC outer jacket and with the raceway utilized.
- B. Contractor shall provide and install all low voltage (120V, 208V, 240V, 480V, etc.) WCC for power distribution equipment and associated hardware designated and required per the CONTRACT PLANS.
- C. Tighten all screws and terminal bolts using torque type wrenches, and/or drives to tighten to the inch-pound requirements of the NEC and UL.
- D. When single WCC in man-holes, hand-holes, vaults, cable trays and other designated location and/or raceway/s are not wrapped together by some other means, such as arc and fireproofing tapes, bundle throughout their exposed length conductor/s entering from each conduit/raceway with nylon, self-locking, releasable cable ties placed at interval not exceeding 12 inches on-centers.

**3.02 INSTALLATION**

- A. Support all conductors in vertical conduits or raceways in the manner set forth in Article 300-19 of the latest revision of the National Electric Code. Do not use lighting fixtures for raceways or circuits other than parallel wiring of fixtures.
- B. Do not make any splices or taps in any conductor except where absolutely required for 120 volt circuits feeding lights or receptacles. Such splicing may only take place in

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

splice/junction boxes. Elapsed time meters are the only exception to not using a junction box.

- C. Tag all power wiring in all pull boxes, wire ways, motor control center wire ways, panel board wiring gutters, light switch boxes, receptacles, disconnect switches etc. Use flame slip-on type tags, approved for this use, as manufactured by "Raychem", or owner approved equal. See Section 16205, Wire and Cable Tagging Standard for additional requirements.
- D. All interconnect wiring going from one compartment to another, or between two separate pieces of equipment must terminate at a terminal block on each end, i.e. entering and leaving a compartment or piece of equipment.
- E. All wiring passing between cabinets shall be protected by a rubber grommet or approved nipple with bushings.
- F. All wire terminations shall be made with a mechanical compression type lug or terminal specifically designed to accept stranded wire. Do not terminate by wrapping the wire around the screw.
- G. Number 8 AWG and larger wire shall utilize a crimper with a die set to install lugs to the wire.
- H. No more than two wires/ lugs per terminal will be allowed unless ring type lugs are used. A maximum of three wires will be permitted if all wires are using ring lugs.
- I. All current transformer loops shall utilize ring terminals and shorting terminal boards to avoid open circuiting the secondary of a CT.
- J. All wiring run to the front door panel shall have a spiral wrap and tie wrapped to protect wires from being pinched between door and panel. A looped (slack) in conductor/s shall be provided to allow door to open freely.
- K. All main panel wiring shall be run in a raceway such as Panduit. All wiring run from the Panduit to the devices shall be neatly run and tie wrapped. If Panduit is not practical, wires shall be neatly run and tie wrapped.
- L. Equipment grounding wire run in conduit shall have an identifying green covering or green color coding at each end terminations and at junction box or pull box locations along its run length.
- M. Where the capacity of a single feeder is great enough to require parallel conductors in more than one (1) conduit, each conduit must contain the same number and length of conductors in all phases (legs) of the feeder, including any neutral conductors per the N.E.C.
- N. Under no circumstance shall circuits above 600 volts and those below 600 volts be pulled in the same conduit.
- O. Separate low level circuits (such as phone line) from noisy and power circuits by a minimum distance of 1 foot.

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

- P. Bolted and compression connections/terminations for electrical conductors shall be thoroughly cleaned and tinned or covered/sealed with a light, pliable, waterproof film of commercial paste or sealant to prevent oxidation and/or corrosion --- applied to cover complete conductor termination and cover/extend past end of conductor insulation. This is typical/required for Wastewater Facilities and hazardous, moisture and corrosive areas. Acceptable conductor/termination sealant manufacturers are Noalox or approved equal. Include sealant submittal data with WCC submittals.
- Q. Where mechanical assistance is used for pulling conductors, a wire pulling compound, Polywater, or equal, having inert qualities that do not harm the wire insulation or covering shall be free from grease, filings or foreign matter before conductors are pulled. Do not exceed cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- R. Wiring shall be tagged with Raychem Wire Markers, or equal, at panel boards, and all termination points with numbers conforming to the City of Austin Wire and Cable Tagging Standard. Power wiring labels shall be white with black letters.
- S. Lighting and receptacle wiring may use silicone filled spring type wire connectors in approved locations. This applies to lighting and receptacle circuits only.
- T. In no case shall DC voltage circuits and AC circuits be pulled in the same conduit or raceway.

**3.03 FIELD TESTS**

- A. Field test, check and inspect all installed WCC --- comply per requirements per Section 16951 "Calibration and Testing".

**END**

**16200**

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

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## **PART 1: GENERAL**

The purpose of this specification is to establish a wire tagging method to use on electrical, control and instrumentation systems for the Austin Water Utility.

## **PART 2: PRODUCT**

### **2.1 Wire Tagging**

In general, all wiring shall be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure; box or space designed for wire pulling or inspection and includes pull boxes, manholes, and junction boxes.

Wire tags shall show both origination and destination information to allow for a wire to be traced from point to point in the field. Information regarding its origination shall be shown in parenthesis.

#### **A. Single Conductor Wire Tagging**

The following is the format to use for single conductor wire tags. Tag information to the left refers to the termination point. Tag information in parenthesis refers to point of origination.

**XXXX XX (XXXX-XXXX-XXXXX / XXXX XX)**

**Device Terminal Identifier No. (Equipment Tag No.\*/Device Terminal Identifier No.)**

\* For wiring within a piece of equipment, control panel, junction box, etc., the Equipment Tag No. is **not** required, only the Device Identifier and Terminal Number from the point of origination.

**Example: For a wire connected from Terminal block 1 terminal 23 to relay CR1 terminal 9, the correct tag would be TB1-23(CR1-9) at the terminal block and CR1-9(TB1-23) at the relay.**

#### **B. Device Identifier**

The Device Identifier uniquely identifies a device within a piece of equipment. Examples are: TB1, for terminal block number 1 and CR02, for control relay # 02. For existing equipment, refer to existing device tags or labels and/or equipment documentation. For missing tags or new equipment, refer to the standards developed by EIC Division.

C. Terminal Number

The Terminal Number along with the Device Identifier, identify which specific point in the equipment the wire must be terminated to. Refer to manufacturer's labeling or record drawings for device terminal numbers.

D. Equipment Tag No

The Equipment Tag Number is the physical tag attached to the equipment. For existing equipment, please refer to the Facility in question. For new or missing equipment tags, refer to the EIC Division Standards for tagging standards.

EXAMPLE: Refer to the back of this document for examples on wire tagging within a piece of equipment and between two pieces of equipment.

E. Device Identifier and Terminal Number

The device identifier and terminal number is the same as in a single wire tag above and it describes what device and terminal number the wire is to be terminated to.

## 2.2 Tag Specifications

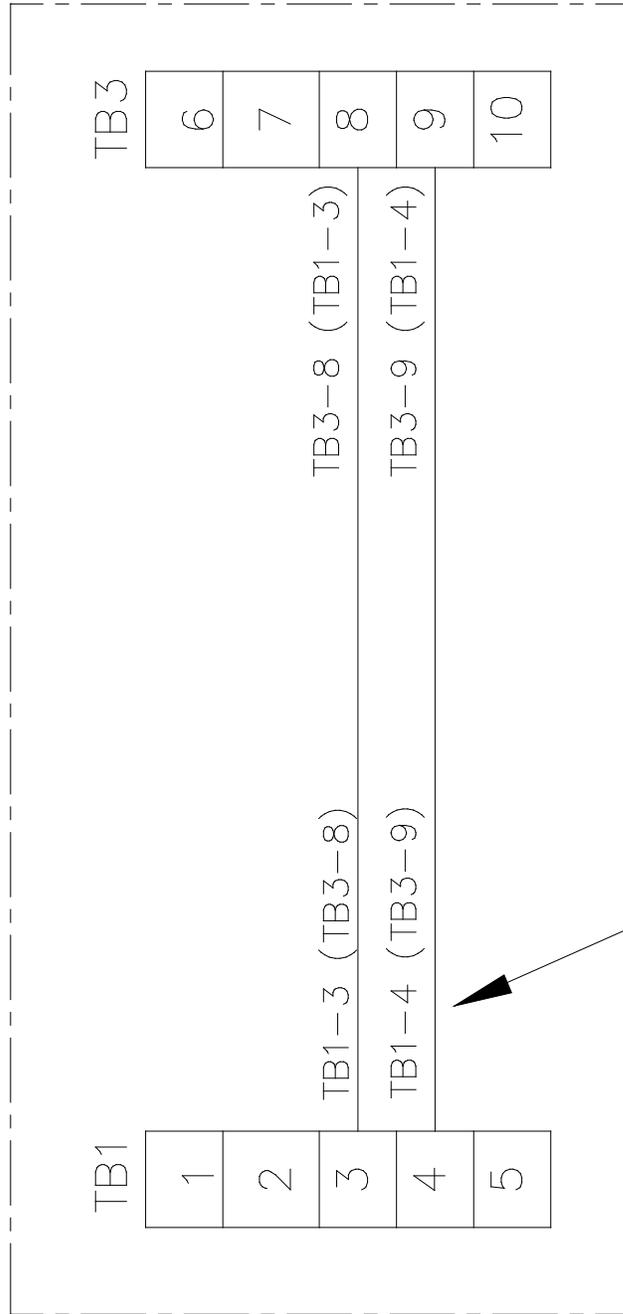
Wire tags shall be **yellow** heat shrink type "Raychem" or Owner approved equal with the tag numbers typed with an indelible marking process. Character size shall be a minimum of 1/8" in height. Hand written tags will **not** be acceptable. Tags shall **not** be heat shrunk unless specifically authorized by owner.

## PART 3: EXECUTION

For deviations from this wire tagging specification, or for cases not covered by these specifications, submit the proposed tagging system to the Electrical Instrumentation and Controls Division staff for approval prior to use.

equipment tag (typ)

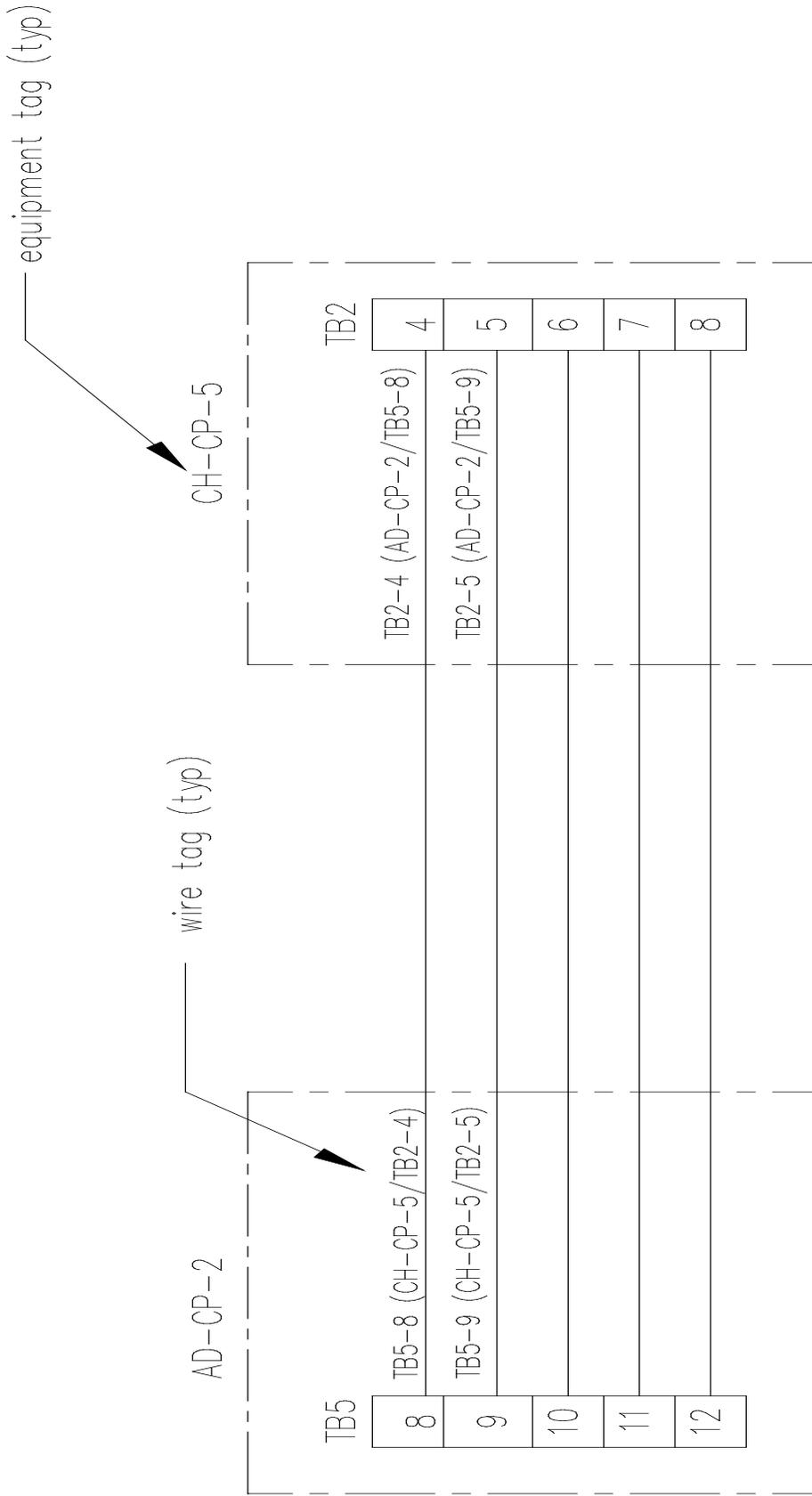
PT-CP-02



wire tag (typ)

**EXAMPLE # 1**

Identification of a Single Conductor within a piece of equipment



EXAMPLE # 2

Identification of a Single Conductor that interconnects two pieces of equipment

## PART 1 GENERAL

### 1.01 WORK INCLUDED

- A. Furnish and install a functional control panel to operate the control system as specified in the detailed mechanical equipment requirements of this Section and the purchase specification.
- B. Obtain all required control descriptions and data from the detailed mechanical equipment requirements to this Section, the System Description and the control schematic diagrams on the Electrical Contract Drawings.
- C. Provide control system engineering to produce custom elementary drawings showing interwiring and interlocking with remote devices.
- D. All control devices, unless specified otherwise, shall be mounted in the control panel.
- E. This section includes control panels supported by equipment Manufacturer's to manually or automatically operate the mechanical equipment.

### 1.02 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE).
- B. National Electrical Manufacturers Association (NEMA).
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### 1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data. The documents submitted shall contain but not be limited to the following:
  - 1. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section. Furnish complete Bill of Materials indicating Manufacturer's part numbers.
  - 2. Power and control schematics including external connections. Show wire and terminal numbers and color coding.
  - 3. Instruction and replacement parts books.
  - 4. Certified shop test reports.
  - 5. As-built final drawings.
  - 6. Field tests and inspection reports.

### 1.04 QUALITY ASSURANCE

- A. A factory authorized service and parts organization shall be able to respond to any service call for the project within 8 hours. Provide the name and address of the factory authorized service and parts organization nearest to the project location at the time of the bid.

- B. Equipment components and devices shall be UL labeled to the extent possible wherever UL standards exist for such equipment.
- C. The control panel Manufacturer shall demonstrate at least three years of continuous field operating experience in control panel design and fabrication. Submit customer/user list with telephone numbers, addresses and names of customer/user representatives.

#### 1.05 SYSTEM DESCRIPTION

- A. Refer to the detailed mechanical equipment specifications for description of system operation.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Package the control panel for maximum protection during delivery and storage.
- B. Store the control panel indoors in a clean, dry, heated storage facility until ready for installation. Do not install the control panel in its final location until the facilities are permanently weather tight. Protect the control panel at all times from exposure to moisture, chemicals, hydrogen sulfide and chlorine gas.

#### 1.07 WARRANTY

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for a period no less than the controlled equipment warranty. Warranty shall be two (2) years from date of substantial completion.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The control panel shall consist of a main circuit breaker, a combination motor circuit protector (MCP), magnetic starter and overload relay for each motor, a 120 volt control power transformer with two fuses on the primary and one fuse on the secondary. All control components shall be mounted in one common enclosure. Control switches shall be provided to operate each motor either manually or automatically.

#### 2.02 RATING

- A. The control panel shall operate on a power supply as indicated on drawings.
- B. The overall withstand and interrupting rating of the equipment and devices shall not be less than 35000 amperes R.M.S, symmetrical at 480 Volts. All circuit breakers and combination motor starters shall be fully rated for the above fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.
- C. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels.
- D. The control panel shall meet all applicable requirements of the National Electrical Code.

- E. The control panel enclosure shall be in accordance with the electrical area classification indicated on the Electrical Contract Drawings.

## 2.03 COMPONENTS

- A. The main circuit breaker shall be a thermal-magnetic molded case breaker, Type FCL or provide a main fused disconnect rated 35 kAIC to limit the let thru current. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.
- B. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.
- C. Motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases.
  - 1. Motor starters shall be 2 or 3 Pole, 1 or 3-phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing except as shown on the drawings. NEMA sizes shall be as required for the horsepower shown on the drawings.
  - 2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the drawings. A minimum of one N.O. and N.C. auxiliary contacts shall be provided in addition to the contacts shown on the drawings.
  - 3. Overload relays shall be adjustable ambient compensated and manually reset.
  - 4. Control power transformers shall be sized for additional load where required. Transformer primaries shall be equipped with time-delay fuses.
- D. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein, as required by the detailed mechanical equipment requirements, Division 16, Division 17 and as shown on the Drawings.
- E. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Drawings.
  - 1. Indicator lamps shall be heavy duty, 30 mm industrial type oil tight, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates. Unless otherwise specified in each equipment specification lens color shall be green for equipment OFF, red for equipment operating, amber for FAIL and white for power ON/Equipment Stand-by. For all control applications, indicator lamps shall incorporate a push-to-test feature.
  - 2. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30 mm, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact

arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.

3. Push-button, shall be heavy-duty, 30 mm, oil tight industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Button color shall be red for START and green for STOP. Contact arrangement shall be as required.
  4. E-stop push button shall be red, non illuminated, mushroom type heavy duty, industrial type with maintained contact, rated for 120 VAC at 10 Amps continuous. Button shall Cutler Hammer HT800 or approved equal.
- F. A six digit, non-resetable elapsed time meter shall be connected to each motor starter.
- G. A failure alarm with horn and beacon light shall be provided as required by contract document. Silence and reset buttons shall be furnished.
- H. The control panel shall be provided with an SPD Unit on the load side of the main circuit breaker. SPD shall be rated 65Ka per mode. SPD shall be provided with over-current disconnecting mean in order to safely remove the SPD while panel is operating.
- I. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 VAC and 10 Amps continuous.
- J. An alternator shall be provided to sequence motors as required by contract document.
- K. Control relays shall have 120-volt coils, 11 pin tubular octal bases with indicating light, and contacts rated for 10 amps. Furnish 1 N.O. and 1 N.C. spare contacts in addition to those required by the control scheme.
- K.L. L. Timing relays shall have 120 volt coils, 11 pin base, selectable for on delay or off delay functions, and settable for time delays of 0.05 seconds to 999 minutes with 10 amp contact rating. Relays shall be Square D class 9050 type JCK70 or equal.
- L.M. Panel mounted timers shall be flush mounted, plug-in type with ranges as shown on the Drawings, or as required by the detailed mechanical equipment specifications and Division 17.
- M.N. Specific control devices, control descriptions and other data are specified under the detailed specification for the mechanical equipment with which the control panel is supplied.
- 2.04 ENCLOSURE TYPES
- A. The control panel specified herein shall be rated NEMA 12 for panels located indoor, NEMA 4X 316 Stainless Steel for panels located outdoors.
  - B. Steel enclosures shall be 12 gauge and constructed with continuously welded seams. The panel door(s) shall have continuous hinge with quarter turn latches and neoprene gasket. Door clamps shall be provided. The enclosures shall be Hoffman Concept or an approved equal.
  - C. The enclosure shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs. The

enclosure door shall be interlocked with the main circuit breaker by a door mounted operating mechanism. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

- D. Print storage pockets shall be provided on the inside of the panel.
- E. Overload tables shall be laminated and adhered to the inside of the door.

#### 2.05 NAMEPLATES MARKINGS AND IDENTIFICATION

- A. Provide 2-in by 5-in, nominal, engraved phenolic master nameplate on the control panel fastened with stainless steel type 316 screws or rivets. Nameplate shall be white with black core, 3/8-in high lettering and shall indicate equipment designation as shown on the Drawing.
- B. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.
- C. Provide permanent warning signs as follows:
  - 1. "Danger- High Voltage- Keep Out" on all doors.
  - 2. "Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on main power disconnect.
  - 3. Arc Flash labels shall be provided for every 480V panel.

#### 2.06 CONDENSATION HEATERS

- A. A strip heater shall be mounted inside the control panel.
  - 1. Heater shall be rated 240V, but operated at 120V, single phase, 150 watts, with rust resisting iron sheath.
  - 2. A control thermostat shall be mounted inside the control Panel.
  - 3. The strip heater terminals shall be guarded by a protective terminal cover.
  - 4. High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation.

#### 2.07 WIRING

- A. All power and control wire shall be flexible 41 strand #14 AWG, 600 Volt insulation type SIS tinned copper, color coded as outlined in specification SS 16200 "General wiring methods" and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.
- B. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.
- C. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers. The numbers used shall be as specified in section SS 16205, Wire Tagging.

## 2.08 TERMINAL BLOCKS

- A. Terminal blocks shall be 600 Volt rated, rail mounted capable of accepting # ~~22-24~~ to # ~~8-12~~ wires. Terminal blocks shall be ~~Westinghouse type TBA, Allen Bradley 1492 series~~ rated for a minimum of ~~25-16~~ amps or equal. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
- B. Wires shall be terminated to the terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated.
- C. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20 percent spare terminals.
- D. Provide an intrinsically safe ground terminal bar isolated from the control panel enclosure. Provide 20 percent spare terminals but not less than two spare terminals.
- E. Terminal points for current transformer leads shall be provided with a shorting bar.

## 2.09 SHOP TEST

- A. Perform Manufacturer's standard production testing and inspection in accordance with NEMA and ANSI standards.

## PART 3 EXECUTION

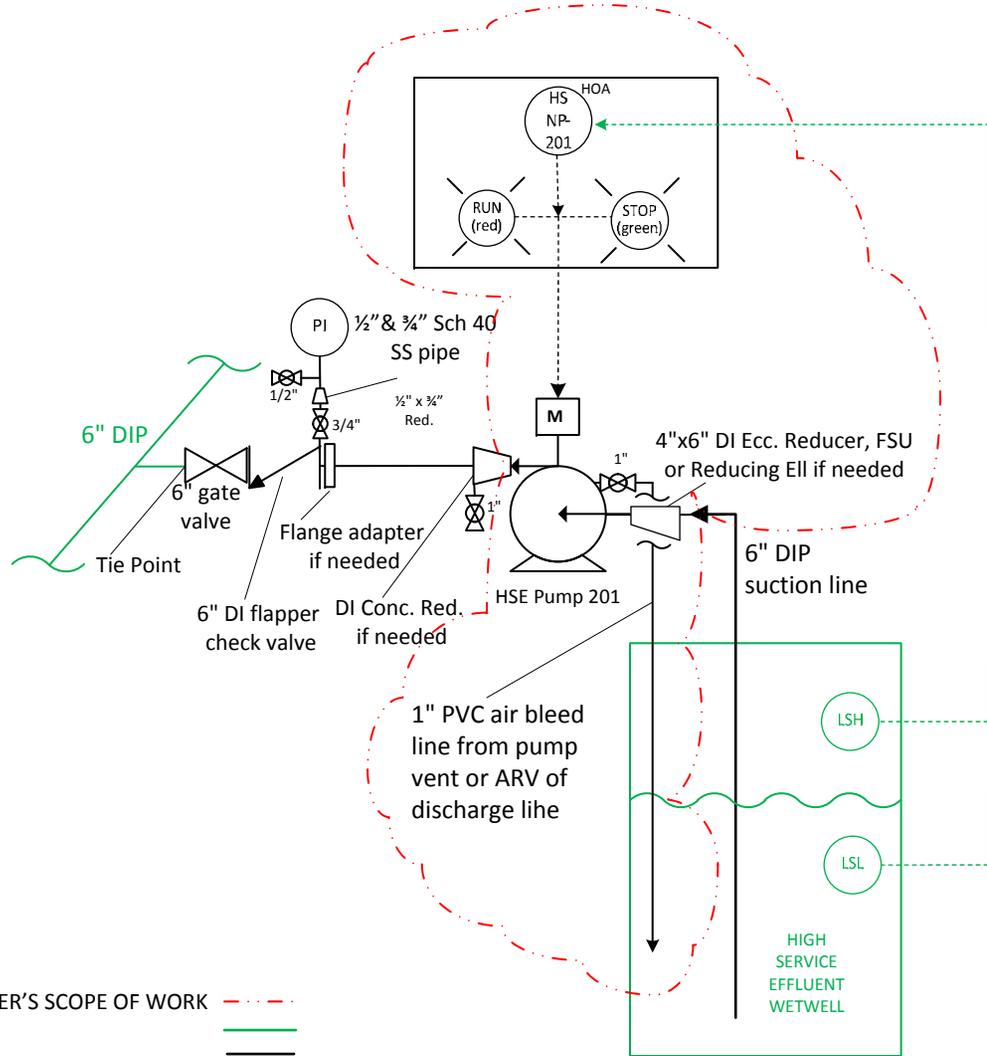
### 3.01 INSTALLATION

- A. Repaint any damage to factory applied paint finish using touch-up paint furnished by the control panel Manufacturer.
- B. Any work not installed according to the Drawings and this Specification shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.

### 3.02 FIELD TESTING

- A. Check mechanical interlocks for proper operation. Make any adjustments required.
- B. Adjust motor circuit protectors and voltage trip devices to their correct settings.
- C. Install overload heaters per actual motor nameplate currents.
- D. Adjust motor circuit protectors for actual motor nameplate currents.
- E. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the control panel Manufacturer's factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

END OF SECTION



**NOTES:**

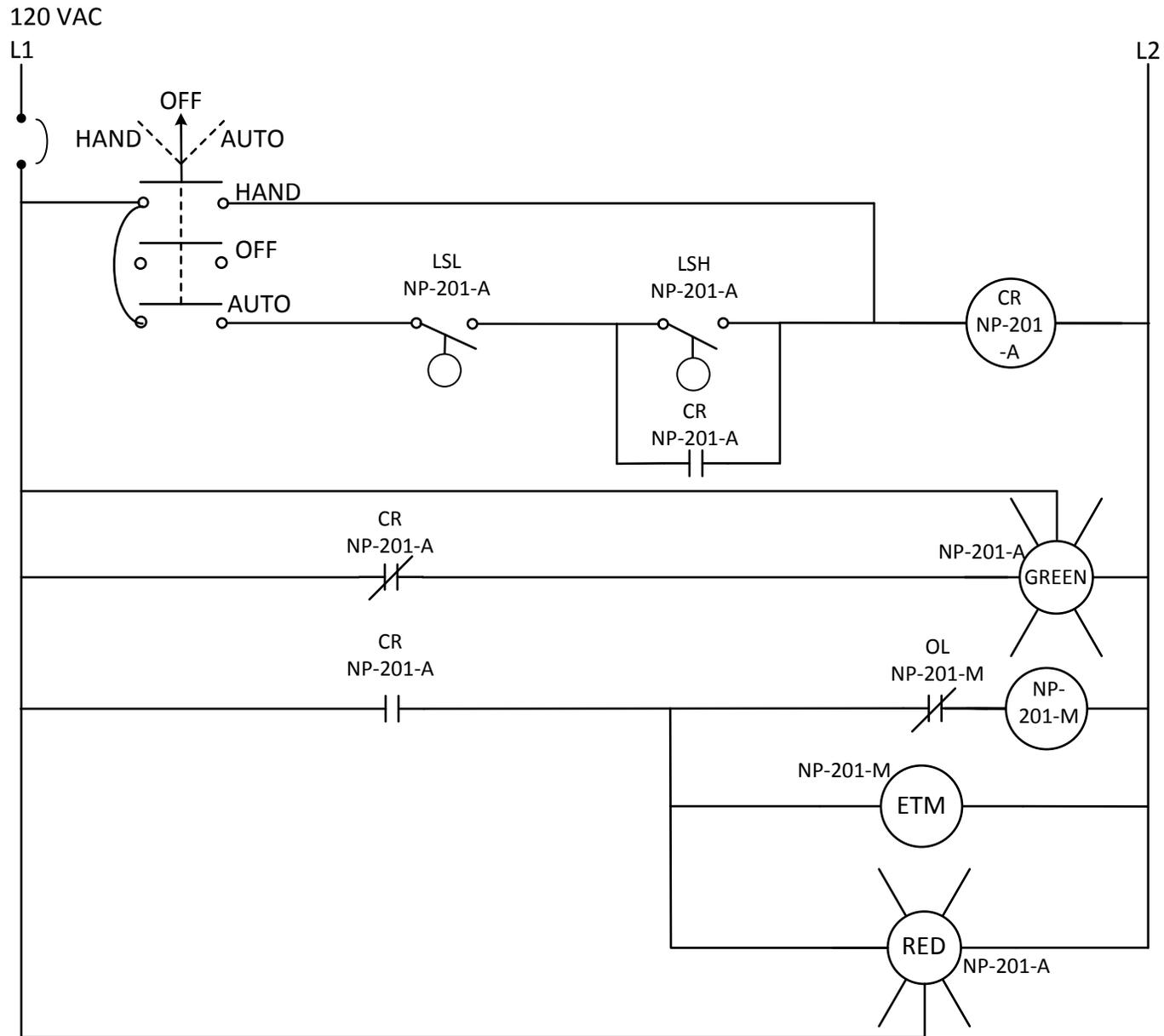
- PUMP SUPPLIER'S SCOPE OF WORK - - - - -
- EXISTING — — — — —
- PROPOSED — — — — —

1. Tie point for mechanical Scope of Work is branch tee flange mating to existing 6" isolation valve
2. Limit of Electrical Scope of Work is to demolish existing and connect new local instruments, switches and lights, and pull new conductors for motor, instrumentation, switches and lights terminating at existing starter bucket in MCC. Install new breaker as necessary to match size of pump motor.
3. Belt drive not shown.
4. Drill and tap reducing fittings and blind for drain valves connections.
5. Support suction line from top, bottom or sides of wetwell.

**LOST CREEK WWTP – HIGH SERVICE EFFLUENT PUMP REPLACEMENT SCHEMATIC**

Scale: None

February 2015



**NOTES:**

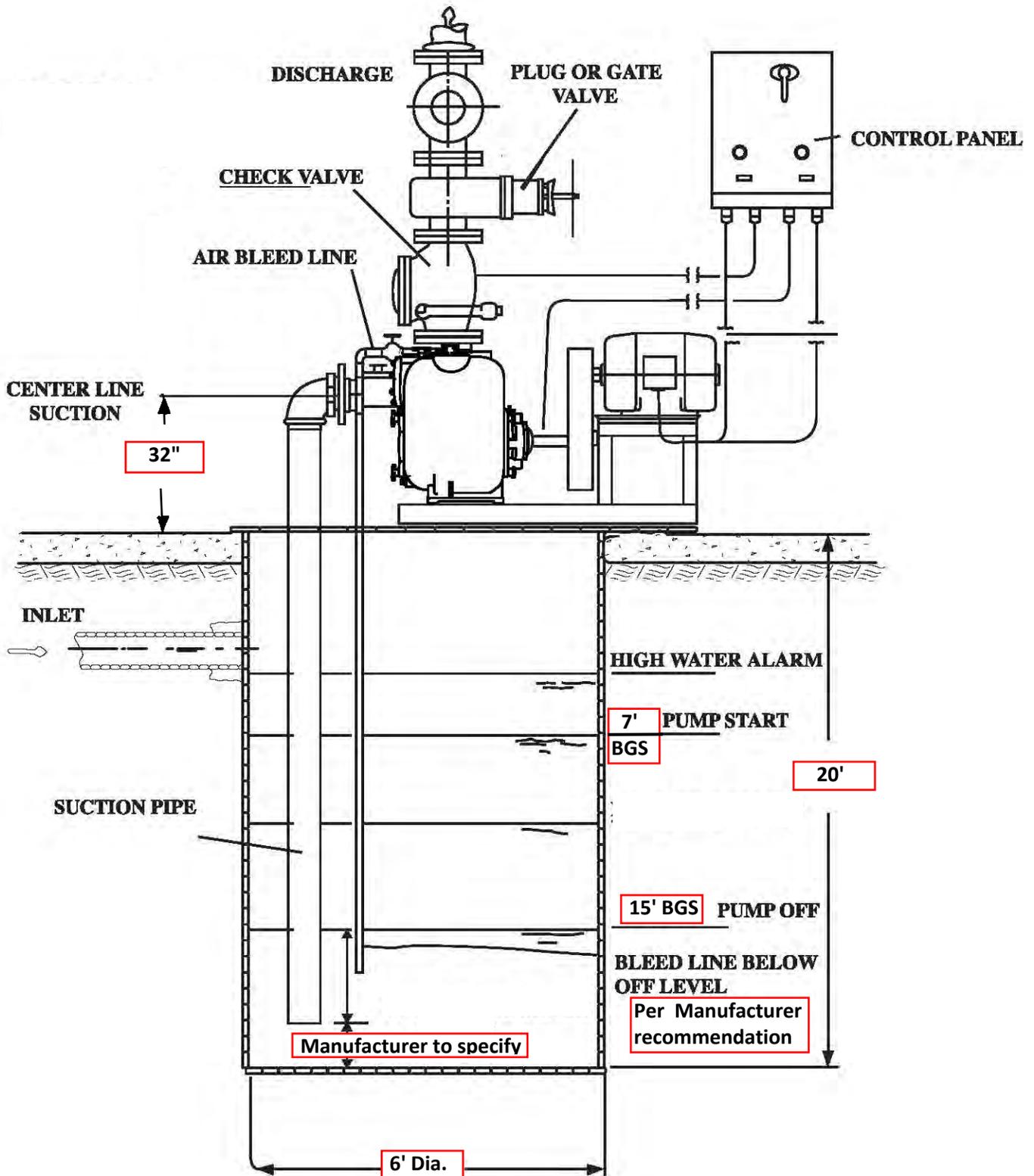
1. In AUTO mode pump shall start and stop based on high and low wetwell level switches, respectively. In HAND mode, pump shall run without regard to wetwell level.
2. Status lights shall have push-to-test functionality.
3. Elapsed time meter and overload relays in MCC, by Others.
4. Wire all extra relay points to terminal block.

**LOST CREEK WWTP – HSE PUMP CONTROL SCHEMATIC**

Scale: None

February 2015

Lost Creek WWTP  
Proposed High Service Effluent Pump  
Wetwell Section





CAUTION  
DO NOT  
OPERATE

CITY OF AUSTIN, TEXAS  
PURCHASE SPECIFICATION

FOR

**LOST CREEK WASTEWATER TREATMENT PLANT  
DUPLEX PUMP SYSTEM FOR PLANT WATER**

1.0 SCOPE AND CLASSIFICATION

1.1 Scope

This specification establishes the minimum requirements for the purchase of a duplex centrifugal pump system to provide treated effluent to meet a wastewater treatment plant's non-potable water (NPW) needs. Contractor shall provide specified equipment and appurtenances and deliver duplex pump system to the Lost Creek Wastewater Treatment Plant.

Contractor shall include time for a factory-trained representative to visit the site and verify proper installation and operation, and provide O&M training.

This specification includes sections on Scope and Classification, Applicable Specifications, Contractor Requirements, Performance Requirements, and Invoicing Requirements.

1.2 Classification

The duplex pump system will be located at Austin Water Utility's Lost Creek Wastewater Treatment Plant, 6104 ½ Turtle Point Road, Austin, TX, 78746.

<u>Date</u>	<u>Prepared by</u>	<u>Issuance/Revision</u>	<u>Approval Department</u>	<u>Approval Purchasing</u>
10-12-2015	Henry Dress	Issuance	Darrell Richmond	Steve Aden

This specification, until revised or rescinded, shall apply to each future purchase and contract for the commodity describe herein. Retain for future use.

## 2.0 APPLICABLE SPECIFICATIONS

2.1 Contractor will be responsible for complying with all Federal and State of Texas standards, including but not limited to rules, regulations, and laws concerning this type of service, including EPA standards that apply to both private industry and governmental agencies. This also includes compliance with applicable OSHA safety guidelines and City of Austin ordinances and regulations, as well as Austin Water Utility (AWU) policies.

2.2 Attachment A, which is comprised of the following technical specification sections, item, schematic and details:

11306 Duplex Horizontal End Suction Centrifugal Pumps

WW 16010 Electrical General Provisions

16150 Raceways, Fittings and Supports

WW 16172 Electric Motor 200hp and Smaller

WW 16191 Miscellaneous Electrical Equipment

16200 Wires, Conductors and Cables – 1000V and Below

WW 16205 Wire Tagging

16550 Grounding

WW 16600 Disconnect Switches and Enclosed Circuit Breakers

WW 16700 Common Control Panel Requirements for Equipment

Lost Creek NPW Pump Schematic

Lost Creek NPW Pump Control Rev

NPW Pump Skid Location photo

## 3.0 CONTRACTOR REQUIREMENTS

3.1 Contractor shall provide equipment, appurtenances and fabrication complying with technical specification sections and schematics in Attachment A.

3.2 Send factory-trained representative onsite to inspect and verify proper system installation.

## 4.0 PERFORMANCE REQUIREMENTS

4.1 The Contractor shall contact the Contract Manager within **five calendar days after award of contract** to establish and mutually agree upon installation duration and schedule and to coordinate with plant operations.

4.2 Contract Manager:

Lauren King, PE

Austin Water Utility, Facility Engineering

625 E. 10<sup>th</sup> Street, Suite 400

Austin, TX 78701

(512) 972-0230

## 5.0 INVOICING REQUIREMENTS

5.1 Invoices shall not arrive prior to project completion. Contractor shall submit an invoice within ten (10) calendar days after substantial completion, which shall be defined by complete commissioning and onsite verification by factory-trained representative of proper system installation and operation.

Lauren King, PE

Austin Water Utility, Facility Engineering

625 E. 10th Street, Suite 400

Austin, TX 78701

- ◇ Invoice shall include, but is not limited to, the following:
- ◇ Contractor's name, on a professionally pre-printed form
- ◇ Contractor's address and phone number
- ◇ City's contract number/purchase order number
- ◇ Date of delivery
- ◇ Location of delivery
- ◇ Itemized description and pricing for each item listed on the bid sheet.
- ◇ Final Invoice shall include "FIXED ASSET PROCESSING FORM" (Attachment B) with highlighted fields completed

# **Attachment A**

**SECTION 11306**

**DUPLEX HORIZONTAL END SUCTION CENTRIFUGAL PUMPS**

**PART 1 GENERAL**

**1.01 SCOPE OF WORK**

Provide single-stage, end-suction, close-coupled centrifugal pumps complete with motors, controls and appurtenances as specified herein to pump non-potable plant water (NPW) to various points onsite.

Furnish two new pumps, motors and control panel on a skid in a duplex configuration. Supply all pumping components, control devices, and equipment necessary to provide a completely operational pump system which meets the requirements of this section and good engineering practices. Skid elevation shall be set so that the pump centerlines match the tank outlet nozzle. Installation of skid and connection to power and tie points will be by Others.

**1.02 PLANT WATER PUMPS**

Quantity	2 (1 duty, 1 standby)
Type of System	Skid-mounted
Liquid Pumped	Non-potable water
Design Flow	60 GPM at 150 ft TDH
Available NPSH	20 feet of water
Hydraulic Efficiency Desired	≥35 Percent
Motor Speed	1800 rpm preferred
Motor Horsepower	Non-Overloading TEFC

**1.03 RELATED WORK SPECIFIED ELSEWHERE:**

- Specification Section WW 16010: Electrical General Provisions
- Specification Section 16150: Raceways, Fittings and Supports
- Specification Section WW 16172: Electric Motors, 200 hp and Smaller
- Specification Section WW 16191: Miscellaneous Electrical Equipment
- Specification Section 16200: Wires Conductors Cables - 1000V and Below
- Specification Section WW 16205: Wire Tagging
- Specification Section 16550: Grounding
- Specification Section WW 16700: Common Control Panel for Equipment

**1.04 GENERAL REQUIREMENTS**

- A. General Provisions of Electrical Specification Section WW 16010 shall apply;
- B. Electrical components and installation shall comply with the provisions of Specification Section 16150;
- C. Electric motor shall comply with provisions of Specification Section WW 16172;
- D. Miscellaneous electrical components shall be provided in compliance with Specification Section WW 16191;
- E. Wiring shall be comply with the requirements of Specification Section 16200;
- F. Wire tagging shall comply with the requirements of Specification Section WW 16205;

- G. Equipment shall be grounded in accordance with the requirements of Specification Section WW 16550;
- H. Control panel shall comply with the applicable requirements of Specification Section 16700; and
- I. Pump and motor shall have position location identification labels per the following table:

Pumps	Motors
PP-LC-NP-001-A	PP-LC-NP-001-M
PP-LC-NP-002-A	PP-LC-NP-002-M

1.05 REFERENCE STANDARDS

This Section contains multiple references to industry standard Specifications. They form a part of this Section as specified. In case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

Reference	Title
ANSI B1.20.1	Pipe Threads, General Purpose, Inch
ANSI B16.1	Gray Iron Pipe Flanges and Flanged Fittings
ANSI B16.5	Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24
ASTM A36	Steel fabrications
ASTM A48	Cast Iron Castings
ASTM A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

1.06 SUBMITTALS

Submit the following with bid documents:

- A. Manufacturer's data: dimensions, materials of construction, and accessories for all components including motor.
- B. Performance curve developed for the specific application. Performance curve shall show speed, capacity, pressure, and power for specified conditions.
- C. A complete and full description of any deviations from or exceptions to the specifications shall be provided by the Contractor. The submittal shall be accompanied by a detailed, written explanation/justification for each deviation.
- D. List of recommended spare parts.

Submit the following after project award:

- E. Applicable calculations indicating basis of design for the system.
- F. Shop drawings, dimensioned and to scale as appropriate, (including arrangement and layout drawings, equipment and skid details). Drawings shall be submitted in electronic format as well as paper copies. A minimum of two paper copies of each drawing shall be submitted. Any resubmitted (and as-built) drawings shall include electronic and hard copies with all changes noted.
- G. Complete wiring and control diagrams.

H. Manufacturer's pump performance curve along with certified shop test report.

Submit the following to close out the project:

- I. Operation and maintenance manuals including, as a minimum, complete installation, operation and maintenance instructions, troubleshooting guides and copies of all approved shop drawings. Videos, photographs, and other material which may aid in the preparation of the O&M manual, as well as training material, shall also be submitted.
- J. Equipment and system warranty letter indicating date of Owner acceptance and warranty duration.

#### 1.07 DELIVERY, HANDLING, STORAGE AND PROTECTION

- A. Contractor is responsible for delivery of all products to Wastewater Treatment Plant site.
- B. Upon receipt, Owner will inspect and notify manufacturer of any problems/damage or confirm delivery. Shipments will be inspected upon delivery to ensure products:
  - Are properly labeled and identified and date of manufacture is clearly visible;
  - Comply with the requirements of this specification section; and
  - Quantities match those on Bill of Lading.
- C. Pumps shall be completely drained prior to shipment. Pumps shall be secured to their skid and crated to facilitate handling and storage. Cover or plug all openings to keep out dirt and foreign matter.
- D. Transport and handle products at all times in a manner suitable to avoid product damage.
- E. Deliver dry and in undamaged condition in the manufacturer's unopened containers or packaging.
- F. Any products damaged during delivery shall be returned and replaced with undamaged products at no additional cost to the Owner.
- G. Pumps and accessories shall be stored and protected in accordance with the manufacturer's recommendations.

#### 1.08 QUALITY ASSURANCE

- A. Manufacturer shall perform factory test to demonstrate compliance with the specified operating conditions and to produce a pump performance curve. The performance curve shall include the following six points:
  1. Rated capacity, i.e., guarantee point
  2. Shut off
  3. Midway between shut off and minimum stable flow
  4. Minimum stable flow
  5. Midway between minimum stable flow and rated flow
  6. Runout, i.e., minimum head

Plot the pump flowrate, discharge pressure, horsepower requirements and efficiency lines adjusted to reflect the test water being pumped.

#### 1.09 WARRANTY

- A. Contractor shall provide both equipment and system warranties. Manufacturers' warranties shall cover 100% parts (including, but not be limited to mechanical seal, wear

plates, housing segments, and motor) and the Contractor's warranty shall cover fabrication and field service labor and instrumentation. Equipment shall be free of defects in design, material, workmanship and fabrication for a period of 12 months from the date of Owner delivery. If any part of the equipment should fail during the warranty period including as a result of wear and tear, it shall be repaired and restored to full and compliant service at no expense to the Owner. A non-Manufacturer's warranty is unacceptable.

- B. Manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

## **PART 2 PRODUCTS**

Pumps shall be horizontal, end-suction, top discharge, single suction, single-stage, centrifugal units with motors in close-coupled configuration. Pumps and motors shall be rated for continuous duty, capable of pumping the specified flow without surging, cavitation, or vibration. Pumps provided shall be manufacturer's heavy duty version with oversized shaft, bearings, bearing frame, etc.

### **2.01 MANUFACTURERS**

Provide two close-coupled pumps as manufactured by one of the following, along with electric motors and all accessories and appurtenances:

- Carver Pump;
- Flowserve;
- Goulds Pump;
- PACO Pump;
- Peerless Pump; or
- Owner approved equal.

### **2.02 COMPONENTS**

#### **A. Pump Casing**

1. Provide casing vent (unless pump design is top center discharge and provides self-venting) and drain connections that could also allow for sampling.
2. Provide replaceable wearing rings.
3. Provide means of sealing casing joint to prevent leakage; o-ring, gasket or equal.

#### **B. Impeller**

1. Single-stage, single suction, enclosed (or semi-open) impeller.

#### **C. Pump Shaft**

1. Alloy steel shaft with stainless steel sleeves.

#### **D. Seal Chamber**

1. Seal chamber components shall be accurately machined to fit casing.
2. Form cover integrally with seal chamber.
3. Provide sufficient thickness to withstand pressure imposed under operating conditions.

#### **E. Bearing Frame and Bearings:**

1. Pump shall be mounted on a heavy-duty cast-in-one-piece cast iron bearing frame designed to house both radial and thrust bearings. Pump bearings shall be designed to carry both radial and thrust loads at both ends of the frame. Bearings shall be grease-lubricated and be regreasable.
2. Bearings shall be rated for an average AFBMA L<sub>10</sub> life of 100,000 hours and mount in machined and dust-proof housings.
3. Provide ends with labyrinth type seals and deflectors to prevent loss of grease and the entrance of contaminants.

F. Skid:

1. Pump and drive shall be supported from cast iron feet or equal mounted atop a painted, heavy-duty fabricated structural steel channel-frame or skid. Welds shall be continuous. Bolt pump feet to skid. Mounting surfaces on skid for the pumps shall be machined flat and parallel with 0.002 inch overall run end-to-end and side-to-side.
2. Stainless steel anchor bolts: provide proper size and quantity of expansion bolts for installation of skid to slab. Provide at least 1 inch of bolt length grouted into slab. Installation by Others.

G. Provide threaded end connections or 125-pound flanged cast iron suction and discharge connections for pump conforming to ANSI B16.1 for flat-face flanges.

H. Coupling: None. Motor shall be close-coupled to pump.

I. Shaft/Coupling Guard (if any rotating components are exposed): ANSI B15.1 and OSHA-compliant, metal construction, securely mounted to pump or base.

2.03 DESIGN REQUIREMENTS:

- A. Pumping unit shall be an end suction, top discharge, horizontal centrifugal pump specifically designed for pumping water with small amounts of free-floating solids.
- B. Pump and motor shall be designed and selected for continuous duty pumping wastewater effluent subject to secondary treatment. Pumped effluent is expected to range in temperature between 45 degrees and 85 degrees °F depending on the season, and have a pH range between 6 and 9, with a free chlorine residual that could occasionally exceed 10 mg/L.
- C. Pump shall have a back pull-out design to facilitate inspection and maintenance.
- D. Rotating components shall be statically and dynamically balanced. The mass of the unit and its distribution shall be such that resonance at operating speed is avoided.
- E. Pump hydraulic efficiency at design point shall be ≥ 35%.
- F. Shaft shall be of sufficient size to transmit the full driver horsepower with a deflection of no more than 0.002 inches at the seal faces.

2.04 OPERATING REQUIREMENTS:

Pump provided under this specification shall be designed for the operating capacity and head of liquid in the table below.

Pump Design Capacity, gpm	Pump Design Total Differential Head, ft	Maximum Shutoff Head, ft	Max. NPSH reqd. ft.	Pump shall pass min. Solids Sphere, inches
60	150	185	25	5/32

- A. The pump shall not overload the motor at any point on the pump performance curve within the limits of stable pump operation.
- B. Noise level of entire pump assembly shall be no greater than 85 dB at 5 feet and meet all OSHA requirements for noise.

2.05 PERFORMANCE REQUIREMENTS:

- A. There shall be no significant change in vibration and noise level over the entire listed range of operating conditions of operating conditions of the pumping system.
- B. Motor shall be non-overloading (not including motor's 1.15 service factor) along all points of the operating line as evidenced by the shop test's performance curve.

2.06 MATERIALS

<b>Pump Component</b>	<b>Materials of Construction</b>
Wear rings	Lead-free iron
Impeller	Ductile iron
Shaft	Alloy (13% chrome) steel
Shaft sleeves	Stainless steel
If flanged connections	Class 125/Class 150 (ASME B16.1/ASME B16.5)
Pump Skid	Fabricated steel (ASTM A36)

<b>Piping Component</b>	<b>Materials of Construction</b>
Flanged equipment, pipe and pipe fittings	Flanged ductile iron (ANSI A21.15; AWWA C115, Thickness Class 53) per COA Item 510: Pipe and Appurtenances
Threaded equipment, pipe connections	NPT male (MNPT) or female (FNPT)
Pump suction, discharge pipe and fittings	Sch. 40 black steel (ASTM A53) with welded fittings and threaded or flanged connections to equipment
Check Valve	2" ductile iron body silent check valve with wafer style ends.
Discharge Isolation Valve	Carbon steel body ball valves with stainless steel balls, EPDM seats and seals, and threaded or flanged end connections.
Vent and Drain Valves	Ball valve, one-piece carbon steel, reduced port, stainless steel ball and trim, 1-inch, 3/4-inch and 1/2-inch FNPT.
Instrument Valves	Ball valve, one-piece stainless steel, reduced port, stainless steel trim, 1/2-inch FNPT. .
Gaskets	Flanged joint gaskets shall be continuous full face gaskets, 1/8-inch minimum thickness of EPDM rubber, preferably of deformed cross section design. Gaskets shall meet all applicable requirements of ANSI/AWWA A21.11/C111 for flange gaskets.

## 2.07 PUMP COMPONENTS

- A. Key impeller to shaft and secure using a lock nut that is easily removable without special tools. Assembly design shall prevent loosening by torque from either forward or reverse rotation.
- B. Cartridge style, pusher type, inside, unbalanced mechanical seal with silicon carbide/silicon carbide seal faces, Hastelloy C spring(s) and FKM o-rings. The cartridge shall include the mechanical seal faces, the seal holder and carrier, and all o-rings. Seal shall be water-flushed with water from downstream of the simplex strainer (equal to Plan 32). Use stainless steel tubing with compression fittings to run water flush to seal chamber.
- C. Pump housing shall use EPDM o-ring or non-asbestos gasket resistant to chlorinated water.
- D. Pump end connections: Class 125/150 ANSI B16.1/B16.5 flanged or threaded ends.

## 2.08 MOTOR AND DRIVE UNIT:

- A. Provide a motor in accordance with Specification Section 16172 and this section.
- B. Pump shall be close-coupled, direct driven.
- C. Provide a TEFC squirrel cage induction motor with a 1.15 service factor using a 480-volt, 3-phase, 60-Hertz power supply.
- D. The service factor for the motors shall not be applied when sizing the motor.
- E. Provide non-contacting bearing isolators conforming to IP 55 for all motor ball bearings.
- F. Preferred motor speed - 1800 rpm.

## 2.09 DUPLEX PUMP SKID

- A. The pump and drive assemblies shall be rigidly mounted on a common heavy-duty fabricated structural steel channel-frame that will be anchored to the existing slab. Mounting surfaces shall be machined flat and parallel so pumps are installed level.
- B. The height of the pump and drive assemblies mounted on the fabricated structural steel channel-frame and the distance between the pump centerlines shall be set so that the pump centerlines match the elevation of the existing suction valve nozzle centerlines. The elevation of the suction piping centerline is approximately 24" above the top of concrete. (Contractor to field verify dimensions prior to fabrication). The size of the skid shall accommodate the dimensions of the new pumps with motors.
- C. Provide leveling screws, one at each skid bolt to facilitate leveling of base.
- D. Ferrous metal channel and frame components shall have surfaces prepped for factory priming and painting. Fabricator shall shop apply a 2-part epoxy top coat.
- E. Simplex strainers: provide two 2-inch simplex basket strainers, iron body, EPDM (or FKM seals if available), flanged ends and 1-1/4" drains. Provide each strainer with two stainless steel (or Monel) baskets, one basket with perforations of 1/16" and the other basket with perforations of 1/8". Eaton Model 30R or equal.

## 2.10 PUMP CONTROL

- A. Pump to be controlled by high pressure switch in pump discharge. If high pressure switch trips running pump, standby pump shall start automatically. Once tripped pump has its basket strainer cleaned, it shall return to service as the standby pump. Each pump shall have a Hand-Off-Auto mounted on local a relay panel. Pump shutdown

shall announce a high pressure alarm light. Pump controls shall include status lights. See NPW Pump Control Schematic.

## 2.11 ANCILLARY ITEMS

- A. Provide reducers and enlargers to conform to the existing suction and discharge piping.
- B. Instrument Devices: Pressure Gage and Valves
  - 1. High Pressure Switches: single pressure switch, diaphragm operated, adjustable setpoint and deadband, SPDT, rated water and dust tight, with terminal block inside the cover. 3-100 psig range, stainless steel pressure chamber, fluorocarbon diaphragm and o-ring, with ½" process FNPT connection. ASCO Series S part # SA11D4/TF10A42B or equal. Initial setpoint = 80 psig, initial deadband = 5 psi.
  - 2. Pump Suction Gage: 3.5" liquid filled, stainless steel pressure, ½" MNPT with 0-25 psig range, (Ashcroft pressure gage Type 35 1009 SWL 04L 25# or equal).
  - 3. Pump Discharge Gages (3): 3.5" liquid filled, stainless steel pressure, ½" MNPT with 0-100 psig range, (Ashcroft pressure gage Type 35 1009 SWL 04L 100# or equal).
  - 4. Instrument valves; ½" FNPT by FNPT, 1-piece stainless steel body and trim, reduced port ball valves with locking lever handles (NIBCO T-560-S6-R-66-LL or equal).
  - 5. 1" or ¾" ball valves (NIBCO T-570-CS-R-66 or equal).
- C. Suction piping shall be minimum 3-inch in diameter and discharge piping shall be minimum 2-inch in diameter with appropriate reducers as needed. Piping shall be welded except where flanges or threaded connections are needed to accommodate specific items and to match to tie points in field.
- D. Drain and pressure switch connections shall be made using Thredolet<sup>®</sup> fittings or equal.
- E. Dissimilar metal flanges shall be separated by dielectric insulators by Spears<sup>®</sup> Manufacturing Company, dielectric flanges by Watts - Series 3200, or equal.
- F. Dissimilar metal threaded connections shall be separated by dielectric insulated unions, HART Industrial Unions, Class 3000 or equal.
- G. Gaskets; 1/8-inch minimum thickness EPDM rubber (Garlock 98206 or equal).
- H. Check valves; silent check valve, 2-inch wafer style, pressure class 125 with a ductile iron body, stainless steel disc, EPDM resilient seat and a heavy duty stainless steel spring (Val-Matic Series 1400A or equal).
- I. HOA selector switch: local, 3-position, non-illuminated selector switch for pump control with Hand-Off-Auto positions, heavy duty metal, NEMA 4/13 dust and water tight, full-size 30-mm diameter, contacts rated for minimum of 10 amps at 120 VAC. Furnish and install with Hand-Off-Auto label. Allen Bradley 3-position selector switch "*Knob Lever Operator*", Catalog No. 800T-J17A or equal.
- J. Pilot Light: local, transformer type, LED, push to test style, amber colored lens, heavy duty, NEMA 4/4X/13 dust and watertight, rated for 10A minimum at 120VAC, full-size 30-mm diameter. Furnish and install with engraved labels "*High Pressure Shutdown NP-001*" and "*High Pressure Shutdown NP-002*". Allen Bradley Pilot Light, Catalog No. 800H-PRTH16A or equal.
- K. Pilot Light: local, transformer type, LED, push to test style, red and green colored lens, heavy duty metal, NEMA 4/13 dust and watertight, rated for 10A minimum at 120VAC, full-size 30-mm diameter. Lights shall be red for run and green for stop. Furnish and install with labels "*Operating Status NP-001*" Run and Stop, and "*Operating Status NP-*

002" Run and Stop. Allen Bradley Pilot Light, Catalog Nos. 800T-PTH16R (red) and 800T-PTH16G (green), respectively, or equal.

- L. Enclosure(s): NEMA-4X Type 316 Stainless Steel gasketed cabinet enclosure.
- M. Instrument stand(s) for relay panel enclosure and instruments as needed: mount to pump skid or provide floor-mount for mounting to existing slab; pipe style, O'Brien Corp., Saddlepak® Model FS52, or field-erected stainless steel Unistrut mounted to slab.

**2.12 SPARE PARTS**

- A. Furnish common spare parts listed below and any manufacturer recommended spare parts in the quantities indicated (or recommended) for both pumps provided. Package parts for prolonged storage, and clearly identify item and equipment to which it applies.

<u>Item</u>	<u>Quantity</u>
Mechanical seal	1
Shaft sleeves (if provided)	1
Bearings	1
Wear rings	1
Gaskets and O-rings	1 set

- B. Also provide one set of any specialized tools for servicing the pumps.
- C. Spare parts shall be identified, tagged and packaged to prevent dirt and moisture from damaging parts during storage.

**2.13 NAMEPLATES AND LABELS**

- A. Provide pump and motor with nameplates using 1/8" thick Type 316 stainless steel. Engrave with Arial or similar font, 1/4" tall letters minimum. Punched for screws and fastened to equipment at factory in an accessible and visible location. Do not paint nameplate.
- B. Identify controls and starters with engraved labels, provide 3-ply, rigid, thermosetting phenolic resin engraving stock, 1/8" thick to label devices. Colors: white-black-white. Engrave with Arial or similar font, 3/4" tall letters and numerals minimum, through top layer to melamine layer. Punched for screws.
- C. Fasteners: Self-tapping stainless steel screws, except contact epoxy adhesive where screws cannot or should not penetrate substrate.
- D. Include the following information on manufacturers nameplates as applicable for equipment items:
  1. The equipment position identification number;
  2. Manufacturer's name, equipment model number and serial number;
  3. Date of manufacture;
  4. For pump – rated flow capacity in gpm and rated total dynamic head in feet of fluid;
  5. For motor - horsepower;
  6. For motor - speed;
  7. For motor - voltage;
  8. For motor - amps; and
  9. For motor - service factor.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Pump skid shall be clean and free of burrs to provide flat surface to allow leveling on top of existing slab.
- B. All ferrous metal components (including galvanized steel components) shall be 2-part epoxy top coated with a gloss, semi-gloss or satin finish after fabrication. Paint color blue, similar to existing tank.

**3.02 INSPECTION, TESTING AND QUALITY CONTROL**

- A. After fabrication, pumps shall be completely tested to ensure compliance with operating requirements.
- B. Testing shall include motor horsepower, discharge pressure and noise level monitoring.
- C. Hydrostatically test piping and equipment in shop with potable water for leaks at the maximum allowable working pressure of the pumps. Tighten fittings, replace gaskets, etc. to address the root cause of the leak.

**3.03 MANUFACTURER’S FIELD SERVICES**

- A. The services of the equipment manufacturer's factory-trained representative(s) shall be furnished to insure that the equipment has been properly installed and tested to provide continuous and satisfactory operation. The Manufacturer shall make, at his expense, all necessary changes, modifications, or adjustments required to assure satisfactory operation. The equipment manufacturer's representative shall also instruct the Owner's personnel onsite in the maintenance and operation of the equipment. Operational training shall include instruction on field adjustment of clearances.
- B. The minimum number of hours required onsite shall not include travel time.

<b>Service Description</b>	<b>Minimum number of hours onsite</b>
Pre-fabrication site visit to field verify dimensions	2
Commission equipment during the operational testing phase and startup period. Includes functional testing and adjustments of the equipment	6
Operator and Mechanic Training	2

**END OF SECTION 11306**

## PART 1 GENERAL

### 1.01 WORK INCLUDED

- A. The work includes, but is not limited to, the following principal systems and equipment:
1. 120/208-Volt System.
  2. 480-System.
  3. Motors.
  4. Motor Control Centers.
  5. Panelboards.
  6. Conduit and Raceways, including underground.
  7. Transformers.
  8. Lighting fixtures and lamps.
  9. Grounding and Lightning Protection.
  10. Conductors.
  11. Miscellaneous Controls and Equipment.

### 1.02 REFERENCE STANDARDS

- A. Perform work, furnish and install materials and equipment in full accordance with the latest issue of the applicable rules, regulations, requirements, and specifications of the following:
1. Local laws and ordinances.
  2. State and Federal Laws.
  3. National Electrical Code (NEC).
  4. State Fire Marshal.
  5. Underwriters' Laboratories (UL).
  6. National Electrical Safety Code (NESC).
  7. American National Standards Institute (ANSI).
  8. National Electrical Manufacturer's Association (NEMA).
  9. National Electrical CONTRACTOR's Association (NECA) Standard of Installation.
  10. Institute of Electrical and Electronics Engineers (IEEE).
  11. Insulated Cable Engineers Association (ICEA).
  12. Occupational Safety and Health Act (OSHA).
  13. International Electrical Testing Association (NETA).
  14. American Society for Testing and Materials (ASTM).
  15. National Fire Protection Association (NFPA).
  16. American Concrete Institute (ACI).
  17. International Building Code (IBC).
  18. Insulated Power Cable Engineers Association (IPCEA).
  19. Association Edison Illuminating Company (AEIC).

- B. Wherever the requirements of the Specifications or Drawings exceed those of the above items, the requirements of the Specifications or Drawings govern. Code compliance is mandatory.
- C. Product Quality: All electrical items shall be new and unused. Items such as cables, transformers, motors, control centers, etc., shall be newly manufactured for this project. Proof of purchase documents shall be provided upon request. Utilize products of a single Manufacturer for each item.

### 1.03 CONTRACT DOCUMENTS

- A. Intent:
  - 1. The intent of the contract drawings or Plans is to establish the types of systems and functions, but not to set forth each item essential to the functioning of the system.
  - 2. Electrical drawings are generally diagrammatic and show approximate location and extent of work.
  - 3. Install the work complete, including minor details necessary to perform the function indicated.
  - 4. In case of doubt as to work intended, or if amplification or clarification is needed, request instructions from the Engineer.
  - 5. It is also the intent of these Contract Documents for the electrical and process system Contractor to coordinate with each other in order to provide a complete and workable system with all wiring, conduit and accessories required which may not be shown on the Plans.
- B. Discrepancies:
  - 1. Review pertinent drawings and adjust the work to conditions shown.
  - 2. Where discrepancies occur between Plans, Specifications, and actual field conditions, immediately notify the Engineer in writing for his interpretation.
  - 3. Dimensions on electrical drawings shall be verified with structural, architectural and mechanical drawings.
- C. Outlet and Equipment Locations:
  - 1. Coordinate the actual locations of electrical outlets and equipment with building features and mechanical equipment as indicated on architectural, structural and mechanical drawings.
  - 2. Review with the Engineer any proposed changes in outlet or equipment location.
  - 3. Relocation of outlets before installation, up to 10 feet from the position indicated, may be directed by Owner without additional cost.
  - 4. Remove and relocate outlets placed in an unsuitable location, when so requested by the Engineer.

### 1.04 REGULATIONS AND PERMITS

- A. Regulations: Work, materials and equipment must comply with the latest rules and regulations of the following:
  - 1. National Electrical Code (NEC).
  - 2. National Electrical Safety Code (NESC).

3. National Fire Protection Association (NFPA70E)
  4. Occupational Safety and Health Act (OSHA).
  5. State and federal codes, ordinances and regulations.
  6. Local Electrical Code.
- B. Discrepancies:
1. The Plans and Specifications are intended to comply with listed codes, ordinances, regulations and standards.
  2. Where discrepancies occur, immediately notify the Engineer in writing and ask for an interpretation.
  3. Should installed materials or workmanship fail to comply, the Contractor is responsible for correcting the improper installation.
  4. Additionally, where sizes, capacities, or other such features are required in excess of minimum code or standards requirement, provide those specified or shown.
- C. Permits: Obtain certificates of inspection and other permits required as a part of the work.

#### 1.05 CONTRACTOR QUALIFICATIONS

- A. An acceptable Contractor for the work under this division must have personnel with experience, training, and skill to provide a practical working system. The Contractor shall have previous water and wastewater experience with at least 5 years in business.
1. The Contractor shall be required to furnish acceptable evidence of having installed not less than three systems of size and type comparable to this project.
  2. The systems must have served satisfactorily for not less than 3 years.
  3. The superintendent must have had experience in installing not less than three systems.
  4. The Contractor shall submit qualifications of his firm and resumes of his personnel who will work on this project.
  5. Contractor shall have performed a minimum of three projects with the Owner.

#### 1.06 GENERAL REQUIREMENTS FOR WORKMANSHIP, EQUIPMENT AND MATERIALS

- A. All electrical work shall be performed by workmen skilled in the electrical trade and licensed for the work by the local authority. (Licensed by the State of Texas)
- B. A licensed Master Electrician will be required for the issuance of a building permit for constructing, installing, altering, maintaining, repairing, or replacing any electrical wiring, apparatus, or equipment on any voltage level. A licensed Master Electrician or a licensed Journeyman Electrician holding a current license in the State of Texas is required to be on the job site during the performance of any electrical work. Master Electrician shall spend minimum of 2 hrs per week at the job site reviewing work completed.
- C. All cable splicing and termination methods and materials shall be of the type recommended by the splicing materials Manufacturer for the cable to be spliced, and shall be approved by the Engineer prior to installation.
- D. All materials and equipment shall be installed in accordance with the approved recommendations of the Manufacturer, the best practices of the trade, and in

conformance with the Contract Documents. The Contractor shall promptly notify the Owner in writing of any conflict between any requirements of the Contract Documents and Manufacturer's directions, and shall obtain written instructions from the Owner before proceeding with the work. Should the Contractor perform any work that does not comply with the Manufacturer's directions or such written instructions from the Owner, he shall bear all costs arising in correcting deficiencies.

- E. All equipment and materials shall be new, unless specifically noted otherwise, and shall bear the Manufacturer's name, trademark and ASME, UL, and/or other labels in every case where a standard has been established for the particular item. Equipment shall be the latest approved design of a standard product of a Manufacturer regularly engaged in the production of the required type of equipment, and shall be supported by a service organization that is, in the opinion of the Owner, reasonably convenient to the site.
- F. It is the responsibility of the Contractor to insure that items furnished fit the space available with adequate room for proper operation and maintenance. He shall make measurements to ascertain space requirements, including those for connections, and shall furnish and install such sizes and shapes of equipment that, in the final inspection, will suit the true intent and meaning of the Plans, Specifications and Contract Documents.
- G. The Contractor shall furnish and install all equipment, accessories, connections and incidental items necessary to complete the work, ready for use and operation by the Engineer/Owner.
- H. When the Engineer/Owner has reviewed equipment submittals and given instructions to proceed with the installation of items of equipment that require arrangements or connections different from those shown on the drawings, it shall be the responsibility of the Contractor to install the equipment to operate properly and in accordance with the intent of the Plans and Specifications, and he shall provide any additional equipment and materials that may be required. The Contractor shall be responsible for the proper location of roughing-in and connections by other trades. All changes shall be made at no increase in the Contract Amount or additional costs to other trades.
- I. The Contractor shall support the installation of all equipment, plumb, rigid and true to line. The Contractor shall determine how equipment, fixtures, conduit, etc., are to be installed, and shall provide foundations, bolts, inserts, stands, hangers, brackets and accessories for proper support whether or not shown on the drawings.

#### 1.07 SHOP DRAWINGS AND PRODUCT DATA

- A. Data Required:
  - 1. Submit shop drawings, product data and all other required information as specified in Division 1. Submittals are required on all products and items to be installed on this project.
  - 2. Submittal data must show Manufacturer's name, published ratings or capacity data, detailed equipment drawing for fabricated items, panel diagrams, wiring diagrams, installation instructions and other pertinent data.

3. Where literature is submitted covering a group or series of similar items, the applicable items must be clearly indicated. Mark through items not being provided and clearly identify all options being provided.
  4. Do not combine submittal for multiple Specifications Sections.
- B. Submittal Items: Submittals are required for all equipment and materials to be used on this project. Submittals shall be complete with all pertinent information and installation details. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the Owner's Representative, and such procedures will not be cause for delay
- C. Terminal Connection Diagrams:
1. Submit terminal connection diagrams for approval prior to any wire installation.
  2. Submit finalized terminal connection diagrams at the end of the Contract.
  3. All Manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.

#### 1.08 SYSTEM RESPONSIBILITY

- A. The Contractor shall be responsible for:
1. Complete systems in accordance with the intent of these Contract Documents.
  2. Coordinating the details of facility equipment and construction for all Specification Divisions which affect the work covered under Division 16, Electrical.
  3. Furnishing and installing incidental items not actually shown or specified, but which are required by good practice to provide complete functional systems.
  4. Coordinate the work with the instrumentation Contractor.
    - a. The Instrument Contractor shall furnish and install the primary and secondary instruments.
    - b. The conduit and wiring to and from the instruments shall be furnished and installed by the Electrical Contractor. Termination in the instrument shall be by the Instrument Contractor.
    - c. All terminations in the control panel shall be by the Instrument Contractor.
    - d. The Electrical Contractor shall provide termination drawings for the instrumentation Contractor.
    - e. The equipment pad for the control panels, consoles and instrument panels shall be furnished by the Electrical Contractor.
    - f. The Electrical Contractor shall coordinate the testing of the electrical system being furnished. He shall be responsible for the equipment he is supplying.
    - g. The Electrical Contractor shall be present at the time of the instrument system testing and start-up. He shall be responsible to coordinate the testing of the facility with the Instrument Contractor, Engineer, and Owner.
    - h. The Electrical Contractor shall coordinate the interface requirement between each starter and control panel furnished under this Contract with the Instrument Contractor.

- B. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the approval of the Engineer.
- C. Submit to the Engineer in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Submit such request as soon as practicable, and within ten (10) days after award of the Contract. Make no such departures without written approval of the Engineer.
- D. Dimensions on electrical drawings shall be verified with structural, architectural, and mechanical drawings.
- E. Where the Contractor is submitting a packaged system, Contractor shall meet the requirements of electrical specifications (16000). This includes field cables, conductors, labeling, relays, terminal blocks, conduits, junction boxes, circuit breakers, combination starters, pushbuttons, pilot lights, and motors. Deviations shall not be accepted, unless approved in writing in advance. Control centers and special control cabinets wired to terminal blocks shall include the Manufacturer's standard quality, unless specifically mentioned to the contrary on the drawings or in the specifications.
- F. Maintain continuity of electric service to functioning portions of the process or buildings during hours they are normally in use. Temporary outages will be permitted during cutover work at such times and places as can be prearranged with the Owner's designated Representative. Give the owner a minimum of one weeks notice prior to any shutdowns. Such outages shall be kept to a minimum number and minimum length of time. Make no outages without prior written authorization of the Engineer. Include costs for temporary wiring and overtime work required in the Contract price. Remove temporary wiring at the completion of the work. The Contractor shall be responsible to provide and pay for temporary power to any facility during construction to facilitate the new construction. If generator is needed Contractor shall be responsible for all the cost associated with, including fuel.
- G. Unless shown in detail, the drawings are diagrammatic and do not necessarily give exact details as to elevations and routing of raceways, nor do they show all offsets and fittings; nevertheless, install the raceway system to conform to the structural and mechanical conditions of the construction.
- H. Cabling inside equipment shall be carefully routed, trained, and laced. Placing cables so that they obstruct equipment devices is not acceptable.

## PART 2 PRODUCTS

### 2.01 PRODUCT REQUIREMENTS

- A. Condition: Materials and equipment provided under these Specifications must be new products of Manufacturers regularly engaged in production of such equipment. Provide the Manufacturer's latest standard design for the type of equipment specified.
- B. NEC and UL: Products must conform to requirements of the National Electrical Code. Where Underwriters' Laboratories have set standards, listed products, and issued labels, products used must be listed and labeled by UL.
- C. NEMA and IEC: Only NEMA rated equipment is acceptable. IEC or dual rated NEMA/IEC equipment are not acceptable.

- D. Space Limitations: Equipment selected must conform to the buildings features and must be coordinated with them. Do not provide equipment that will not suit arrangement and space limitations.
- E. Factory Finish: Equipment must be delivered with a hard surface, factory-applied finish so that no additional field painting is required.
- F. Field Installation: All field installed equipment, conduit, etc., shall require Type 316 stainless steel nuts, bolts, washers, metal framing and supports, and other items as indicated on the Plans.
- G. Seismic Design: All electrical equipment to be designed in accordance with/IBC-2006 & ASCE 7-05 code for Seismic Design.

### PART 3 EXECUTION

#### 3.01 PROTECTION OF EQUIPMENT

- A. Moisture:
  - 1. During construction, provide heaters to protect switchgear, transformers, motors, control equipment, and other items from moisture absorption and corrosion.
  - 2. Apply protection immediately on receiving the products and provide continuous protection.
  - 3. Store all equipment indoors in dry, well ventilated and heated space.
- B. Clean: Keep products clean by elevating above ground or floor and by using suitable coverings.
- C. Damage: Take such precautions as are necessary to protect apparatus and materials from damage. Failure to protect materials is sufficient cause for rejection of the apparatus or material in question.
- D. Finish: Protect factory finish from damage during construction operations and until final acceptance of the project.
- E. Protect Equipment per the Manufacturer's requirements.

#### 3.02 INSTALLATION

- A. Cooperation with Other Trades:
  - 1. Cooperation with trades of adjacent, related or affected materials or operations, and of trades performing continuations of this work under subsequent contracts, is considered a part of this work in order to effect timely and accurate placing of work and to bring together, in proper and correct sequence, the work of such trades.
  - 2. Coordinate equipment layout in sufficient time to be coordinated with work of others, provide drawings and layout work showing exact size and location of sleeves, openings or inserts for electrical equipment in slabs, walls, partitions and chases.
- B. Workmanship: Work must be performed by workmen skilled in their trade. The installation must be complete whether the work is concealed or exposed.
- C. Concrete Equipment Pads:

1. Install minimal 4-inch-thick concrete housekeeping pads with chamfered edges for indoor and outdoor floor mounted equipment.
2. Pour pads on roughened floor slabs, sized so that outer edges extend a minimum of 3 inches beyond indoor equipment.
3. Exterior pads shall extend one foot beyond the equipment, including cooling fins.
4. Trowel pads smooth and chamfer edges to a 1-inch bevel.
5. Provide dowels in slab, and rebar between the dowels.
6. Pads must drain away from the equipment.
7. Secure equipment to pads as recommended by the Manufacturer.
8. Follow structural detail where applicable.

D. Setting of Equipment:

1. Equipment must be leveled and set plumb.
2. Stainless Steel 316 enclosures mounted against a wall must be separated from the wall not less than 1/2-inch by means of corrosion resistant 316 Stainless Steel spacers or by 3- inches of air for freestanding units. Mount on shallow 316 Stainless Steel unistrut.
3. Stainless Steel 316 bolts, nuts and washers to anchor the equipment.

E. Sealing of Equipment:

1. Permanently seal outdoor equipment at the base using cocking and areas around conduits using grout.
2. Seal or screen openings into equipment to prevent entrance of animals, birds and insects.
3. Use stainless steel mesh with openings not larger than 1/16-inch squares for screened openings.
4. Seal small cracks and openings from the inside with silicone sealing compound.

F. Concealed Work: Conceal electrical work in walls, floors, chases, under floors, underground and above ceilings except:

1. Where shown or specified to be exposed. Exposed is understood to mean open to view.
2. Where exposure is necessary to the proper function.
3. Where size of materials and equipment precludes concealment.

### 3.03 TESTING

A. Test Conditions:

1. Place circuits and equipment into service under normal conditions, collectively and separately, as may be necessary to determine satisfactory operation.
2. Perform specified tests in the presence of the Engineer, as specified in Division 1 - General Provisions and 16 - Electrical.
3. Furnish all instruments, wiring, equipment, and personnel required for conducting tests. Engage the services of an independent contractor where required. Test equipment shall be calibrated within the last 6 months.
4. Demonstrate that the equipment operates in accordance with requirements of the plans and specifications.

5. No process equipment is to be operated until all associated HVAC equipment and auxiliary equipment is operational.

- B. Test Dates: Schedule final acceptance tests sufficiently in advance of the Contract completion date to permit completion of any necessary adjustment or alterations within the number of days allotted for completion of the Contract.
- C. Retests: Conduct retests as directed by the Engineer of such time duration as may be necessary to assure proper functioning of adjusted or altered parts or items of equipment. Any resultant delay as a result of such necessary retests does not relieve the Contractor of his responsibility under this contract. Provide notice to Engineer and Owner of testing 30-days prior to testing.

### 3.04 PROJECT RECORD DOCUMENTS

- A. Preparation:
  - 1. At the job site, maintain a set of white prints of the contract drawings.
  - 2. At the job site, maintain a set of equipment terminal connection diagrams.
  - 3. On the prints, record field changes and diagrams of those portions of work in which actual construction is at variance with the contract drawings.
  - 4. Mark the drawings with a carmine red pencil. Record installed feeder conduits, dimensioning the exact location and elevation of the conduit.
- B. Delivery: Deliver record drawings to the Engineer in the number and manner specified in Division 1 - General Requirements.

### 3.05 CUTTING AND PATCHING

- A. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of the Engineer. Carefully carry out any cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces neatly to original condition.

### 3.06 LOAD BALANCE

- A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, etc.

### 3.07 MOTOR ROTATION

- A. Before and after final service connections are made, check and correct as necessary the rotation of motors.
- B. Coordinate rotation checks with the Engineer and the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor verifying that rotation has been checked and corrected.

3.08 CLEANING AND TOUCH-UP PAINTING

- A. Touch up scratches, scrapes, or chips in interior and exterior surfaces of devices and equipment with finishes matching as nearly as possible the type, color, consistency, and type of surface of the original finish. If extensive damage is done to equipment paint surfaces, refinish the entire equipment in a manner that provides finish equal to or better than the factory finish, and that meets the requirements of the Specifications and is acceptable to the Engineer.
- B. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps of equipment shall be left on the premises.
- C. All temporary wiring, wiring devices and associated equipment shall be removed upon completion of the project.

3.09 MEASUREMENT AND PAYMENT

- A. No separate measurement and payment will be made for work under the Division 16 Specifications. Include cost of same in Contract price bid for work of which this is a component part.

END OF SECTION

**PART 1: GENERAL****1.1 Description and Scope of Work**

This section specifies raceways, fittings, and supports for all cables, conductors and electrical equipment. The contractor shall furnish and install complete raceway systems in accordance with the following specifications.

**1.2 References**

<u>Code</u>	<u>Title</u>
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NFPA 70	National Electrical Code (NEC)
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<u>Standard</u>	<u>Title</u>
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NEMA 250	Enclosures for Electrical Equipment (1,000 volts maximum)
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ANSI C80.1	Rigid Aluminum Conduit and Rigid Galvanized Steel Conduit
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ANSI C80.4	Fittings and Supports for Conduit and Cable Assemblies
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NEMA TC2	Electrical Plastic Tubing (EPT) and Conduit (EPC-40)
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NEMA TC3:	PVC Fittings for Use with Rigid PVC Conduit and Tubing.
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UL7 514B	Fittings for Conduits and Outlet Boxes
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UL 651:	Schedule 40 Rigid PVC Conduit
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**1.3 Submittals**

A. Submittals shall be made in accordance with the requirements of Section WW-01300, "Submittals".

B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section WW-01730.

**PART 2: PRODUCT****2.1 Exposed-Outdoor Above Ground Level**

A. Rigid Aluminum Metal Conduit System

Conduit run above ground shall be U.L. listed 99 % copper free rigid aluminum and meet the requirements of ANSI C40.5. Conduit pipe straps and hardware to be 316 stainless steel. Conduit shall be manufactured by “Allied Company”, or approved equal.

**Minimum above grade conduit size for all work shall be 3/4-inch. Minimum underground conduit size for all work shall be one (1) inch.**

B. Conduit Seals

Conduit seals to be suitable for use in class-I, group B, C, and D, and class-II group F and G. Conduit seals shall also meet or exceed the following minimum requirements:

1. Seal body, nipples and closures shall be 99% copper-free aluminum. Seals bodies shall be filled with **3M 2123 Re-Enterable Sealing Compound**.
2. Drain: Stainless steel
3. Removable Nipples: 99% copper-free aluminum
4. Seals can be installed/removed without disassembling the conduit system.

Conduit seals to be manufactured by “Crouse-Hinds” type EYS drain seals with specified options, or approved equal.

Seals to be installed directly adjacent to, and, just immediately before entering wet well junction box. See details on drawings.

C. Conduit Hubs

Conduit hubs shall be the grounding type, 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by “Myers”, or approved equal. Conduit hubs shall be furnished complete with rubber gasket.

D. Grounding Bushings

Conduit grounding bushing shall be 99% copper-free aluminum (body, nipples, etc.), with integral insulated throat, and with solder-less grounding lugs as manufactured by Meyers type STAG, or approved equal.

E. Conduit Bodies

All conduit bodies shall be 99% copper-free aluminum. Conduit bodies shall be manufactured by “Crouse-Hinds” Form 7, or approved equal.

F. Conduit Body Covers

Conduit Body Covers shall be die cast aluminum with 316 stainless steel screws. Snap on covers are unacceptable. Supply gaskets with all covers.

G. Conduit Unions

Conduit unions shall be threaded, 99% copper-free aluminum. Conduit unions shall be manufactured by “Crouse-Hinds” type UNF or UNY, or approved equal by “Appleton” or “O.Z. Gedney”.

H. Clamp Backs

Single runs of conduit may be supported with cast aluminum clamp backs with stainless steel hardware and standoffs.

I. Conduit Straps

All conduit straps shall be 316 Stainless Steel unless indicated differently by the plans and or specifications.

**2.2 Underground Conduit System in Duct Bank System and Conduit Concealed in Concrete**

Conduit run underground in duct bank system shall be schedule 40 PVC, U.L. rated, No. 651, conforming to NEMA standard TC-2-75 and listed in conformity with Article 347 of the national Electrical Code (NEC). The conduit is to be manufactured by “Carlton”, or approved equal. Solvent weld shall be a type approved by the conduit manufacturer.

The transition point from underground duct bank to above ground raceway system shall be made utilizing PVC coated rigid galvanized steel (RGS) conduit. PVC coated RGS conduit shall be coated with a 40 mil exterior coating of PVC and a 2 mil urethane interior coating. The coating system shall be in compliance with ETL PVC-001. Refer to Part 3-Execution of this Section, and to details provided on the contract drawings. PVC Coated Rigid Galvanized Steel conduit shall be Plasti-Bond REDH2OT or Perma-Cote coated conduit as manufactured by Rob Roy. A manufacturer’s installer certification shall be required for electricians installing the PVC coated RGS conduits.

The minimum depth of a duct bank is 24” to the top of the Concrete.

**Minimum conduit size for all underground work shall be 1-inch.**

### **2.3 Liquid Tight Flexible Conduit**

Liquid tight flexible conduit shall be non-metallic (NM) type liquid tight flex for sizes ¾" through 2". For sizes 2 ½" and larger provide standard seal tight flex with aluminum core, formed from PVC plastic. Provide aluminum or nonmetallic liquid tight fittings that are suitable for installation in temperature range between -20 degrees C to +60 degrees C (suitable for use outdoors and indoors). Liquid tight flexible conduit and fittings shall be as manufactured by "Electri-Flex" series NM type B-PVC, Thomas & Betts type LT-38P, or approved equal. ½" type NM flexible liquid tight conduit may be used for instruments having ½" threaded entry point.

Liquid tight flexible conduit shall be used for connections to motors, field instruments, etc., and any equipment subject to vibration, and, where shown on the drawings. Maximum length to be 36" unless otherwise noted on drawings or approved by the owner or engineer.

### **2.4 Electrical Equipment and Raceways Support Channels**

Electrical equipment and raceway support channels shall be fabricated with 316 stainless steel material manufactured by "Unistrut Corporation" series P-1000SS and P-1001SS, or approved equal. All fastening hardware, fittings, supports, base posts, clamps, framing system, etc. shall also be fabricated with 316 stainless steel. Manufacturer shall be "Unistrut Corporation," or approved equal.

## **PART 3: EXECUTION**

### **3.1 General**

Install electrical equipment and raceway system conduit in accordance with the recommendations of the manufacturer, the requirements of the National Electrical Code, local codes, and the contract drawings and these specifications.

Use only persons skilled and licensed in the state of Texas to perform this type of work.

### **3.2 Conduit System**

A. Install Schedule 40 PVC conduit underground in reinforced duct banks changing to PVC coated rigid galvanized steel conduit at the final factory 90 degree bend, transitioning from underground to the above ground conduit system. The transition from PVC coated

## RACEWAYS, FITTINGS, AND SUPPORTS

- RGS to aluminum rigid shall be made at a minimum of 6" above the ground, finished slab, and/or housekeeping pad. Duct banks and/or conduit banks shall remain reinforced (along the entire length utilizing stirrups on a minimum of 2'-0" spacing and chairs at a 5'-0" spacing), encased in red concrete to its final destination even when routed under building/structure, concrete floor slab, and/or equipment concrete/housekeeping concrete pad. Rebar shall be kept a minimum of 2" off of the ground to allow complete concrete coverage. There shall be a minimum cover of 24" to the top of concrete for all duct banks. Concrete shall be 3000 psi. A red add mixture, HBS #120 Conduit Red as manufactured by ChemSystems, Inc., or equal, shall be added to the concrete at a minimum of 12 pounds per cubic yard of concrete. Forms shall be used except that side forms are not necessary where the earth is firm enough to support the concrete.
- B. Run exposed conduit parallel or at right angles to building lines.
  - C. Secure conduits to all cabinets and boxes with specified hubs and bonding jumpers in such a manner that each system is electrically continuous throughout.
  - D. Install all conduits as a complete system before wiring is pulled in. Conduits shall be reamed and swabbed clean immediately before wiring is pulled in.
  - E. Cap conduits during construction to prevent entrance of dirt, trash, and water.
  - F. Equip conduit across structural joints, where structural movement is allowed with an O.Z./Gedney, or equal, 99 % aluminum expansion fittings of that conduit size.
  - G. Conduit nipples shall have two independent sets of threads. Running threads shall not be used. Where conditions require joining two fixed conduits into a continuous run, a conduit union shall be used.
  - H. Coat all conduit threads with a Noalox, Penetrox, or approved equal.
  - I. Provide a minimum of 2-inches separation utilizing Plastic conduit chairs between conduits installed in concrete duct bank. Spacing may be less at panel boards, pull or junction boxes or other locations where the conduits have to be grouped.
  - J. Conduit Penetrations:
    - 1. Use 3M 20mil corrosion tape to protect raceways for penetrations through walls, floors, and block outs and grout once work is complete. The tape should extend 6" beyond the walls or floors.
    - 2. **Link-Seal** modular seals shall be used for all subgrade conduit penetrations.
    - 3. **PVC** pipe shall be used for all pour-in-place concrete conduit penetrations.

- K. Maintain 6” clearance between conduit and piping and 12” clearance between conduit and heat sources such as flues, steam pipes and heating appliances.
- L. Arrange conduits to maintain headroom and present a neat appearance.
- M. Conduits run above ground shall be supported at least every 10 feet and once in every change in direction and at the end of each straight run terminating in an enclosure and within three feet of every junction box.
- N. Secure conduit runs firmly to specified support channels by stainless steel conduit straps or by hangers, as required.
- O. Top of duct bank shall be installed a minimum of 24 inches below grade and shall slope 3 inches per 100 feet from high points toward the manholes.
- P. All underground conduit joints shall be waterproofed in accordance with the manufacturer’s recommendations
- Q. Rigid conduit joints to be cut square, threaded, reamed smooth and drawn up tight. Bends or offsets to be made with standard conduit ells. Make field bends with an approved bender or hickey or hub type conduit fittings. Conduit shall contain no more than the equivalent or three (3) 90 degree bends between outlets or fittings.
- R. Backfilling shall be done in such a manner that voids will be minimized. Tamp backfill so that it is the same density as the surrounding soil. Excess soil shall be piled on top and shall be well tamped. All rock and debris shall be removed from the site.
- S. Conduits joints to be staggered a minimum of 6”.
- T. Where a duct bank penetrates or turns up next to a structure, dowel rebar a minimum of 4” into the structure at the point of connection/intersection tying the steel reinforcing of the duct bank to the structure at a minimum of four locations.
- U. All duct banks shall be placed under building slab (not in building slab) with longitudinal duct bank steel reinforcement tied to building slab steel reinforcement with an 18-inch overlap.
- V. Conduits shall penetrate building slab at 90 degrees and shall run in duct banks under building slab and **not** run parallel though building slabs.

### 3.3 Installation of Support Channels

- A. Utilize 316 stainless steel support channels to install raceways, and any other surface mounted electrical, instrumentation and control equipment. Refer to details shown on the contract drawings.

- B. All mounting hardware and straps shall be 316 stainless steel.

## PART 1 GENERAL

### 1.01 WORK INCLUDED

- A. **Equipment:** This section specifies general requirements for fractional and integral horsepower electric motors 200hp and below with a voltage rating of 480VAC or below. Unless otherwise specified, provide motors meeting the basic requirements for high efficiency premium insulation general-purpose alternating current motors, as defined in NEMA MG 1.
- B. **Unit Responsibility:** Motors shall be furnished under other sections of this specification as a part of the driven equipment. The contractor is responsible for all coordination between the various components, as well as for the warranty.
- C. **Exceptions:** Exceptions to this section are listed in the various sections that specify motor-driven equipment or are indicated on the drawings.
- D. Motors connected to variable frequency drives shall be inverter duty rated; each bearing on the non-drive end shall be insulated.
- E. This specification does not cover Submersible Motors.
- F. This specification does not cover horizontal pump motors described under Section 16045 "Horizontal Pump Electrical Motor."

### 1.02 REFERENCE STANDARDS

- A. The following standards shall apply as if written here in their entirety:
  - 1. ANSI/NEMA MG1 - Motors and Generators.
  - 2. ANSI/UL 674(A) - Safety Standard for Electric Motors and Generators for Use in Hazardous Locations, Class II, Groups E, F and G.
  - 3. ANSI/UL 674(B) - Safety Standard for Electric Motors and Generators for Use in Hazardous Locations, Class I, Groups C and D.
  - 4. NFPA 70 - National Electrical Code (latest Edition).
  - 5. IEEE 112 - Standard Test Procedure for polyphase induction motors and generators.
  - 6. UL 1004 - Electric Motors.

### 1.03 WARRANTY

- A. **Special Warranty:** Manufacturer's standard form in which manufacturer agrees to repair or replace components that fails in materials or workmanship within specified warranty period. The warranty period shall start at substantial completion.
- B. **Warranty Period:** No less than the driven equipment warranty.

## 1.04 SUBMITTALS

- A. Requirements: Refer to, Division 1 and Division 16 and to the specific driven equipment sections.
- B. Information: Include the following information on the attached motor data sheet.
  - 1. Manufacturer.
  - 2. Rated full load horsepower and speed.
  - 3. Rated volts at 60 Hz.
  - 4. Number of phases at 60 Hz.
  - 5. Frequency in hertz.
  - 6. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
  - 7. NEMA design letter.
  - 8. Bearing Type.
  - 9. Service Factor.
  - 10. Nominal speed at full load.
  - 11. Full Load Amperes (FLA)
  - 12. Efficiency at 1/2, 3/4 and full load.
  - 13. Power factor at no load, 1/2, 3/4 and full load.
  - 14. NEMA insulation system classification. For motors installed outdoors, include information showing compliance with the intent of paragraph 2.3D.
  - 15. Corrosion duty rating
  - 16. Fan, end bell cast evidence.
- C. Integral Horsepower Motors 40HP and Larger: In addition to the information listed above, include:
  - 1. No load amperes.
  - 2. Safe stall time.
  - 3. Maximum guaranteed slip at full load.
  - 4. Motor damage curves for motors larger than 100HP.
  - 5. Motor manufacturer recommended maximum power factor correction capacitor KVAR for a power factor of 0.95.
- D. Include the motor data sheet at the end of this section in submittal.
- E. The motor manufacturer shall provide in writing that he has coordinated the motor data with VFD and or RVSS manufacturer and that the motor is suitable for VFD or RVSS application.
- F. Submit a letter showing all the exceptions to the specification. If no exceptions are taken, the letter shall indicate no exceptions. Submittal will be rejected without preliminary review if the letter is not submitted.

## PART 2 PRODUCTS

### 2.01 RATING

- A. Speed and Size:

1. Speed and horsepower sizes are specified in the driven equipment specification sections or are indicated on the drawings.
2. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity.
3. Size motors so as not to overload at any point throughout the normal operating range.
4. Furnish dual speed motors of two speed, two winding type, when specified.

B. Frequency: 60 hertz.

C. Service Factor: 1.15 for all motors.

## 2.02 DESIGN TYPE

A. Motors Smaller Than 1/6 Horsepower: Provide single-phase 120 volts, induction motors with integral thermal protectors.

B. Motors 1/6 Through 1/2 Horsepower: Provide single-phase 120 volts, NEMA Design N, induction motors.

C. Motors Larger Than 1/2 Horsepower: Provide 3-phase, 480 volts NEMA Design B, induction motors unless specified otherwise.

D. Acceleration NEMA Time: If the calculated acceleration time of the combined motor and driven load exceeds 3 seconds at 90 percent of rated voltage, request review by the Engineer. Do not proceed with manufacturing without approval.

E. All induction motors shall have squirrel cage rotors.

F. Motor shall be suitable for outdoor environment.

## 2.03 MOTOR INSULATION AND WINDING

A. Class: Use a Class F insulation with temperature Rise of Class B or better above 40°C ambient at 1.15 service factor, meeting the requirements of NEMA MG 1 section 12.40.2 and made of non-hygroscopic materials. The insulation shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalies, and mechanical or thermal shock for 480-volt motors.

B. All stator winding conductors shall be copper.

C. Insulation for inverter duty motor shall meet or exceed the Pulse Endurance Index for magnetic wire and shall not be damaged when exposed to repeated pulse type wave forms, repetitive high voltage transients, switching frequency and rate of rise of the pulse. All bearings on the non-drive end shall be insulated.

D. Outdoor Suitability, all motors must be suitable for outdoor installation.

## 2.04 ROTOR

A. Motor shall have aluminum bar rotor fabrication/construction.

## 2.05 GROUNDING CONNECTIONS

- A. Ground provisions shall be furnished per NEMA STANDARD.
- B. For motors less than 1/6 HP, each motor shall be furnished with provision for attaching a ground connection to the motor frame inside the motor terminal housing.

## 2.06 LEADS

- A. For motor leads, use not less than ASTM B 173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph.
- B. Provide permanent identification numbers on leads according to NEMA MG.
- C. Use crimp-on, solderless tinned copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals for motors 1/2 Hp and below. Terminations on motors 1/2 Hp and larger to be made with Polaris Block type connectors.
- D. Or approved equal.

## 2.07 ENCLOSURE

- A. Use enclosure type as follows:
  - 1. Indoors: Totally enclosed, fan cooled (TEFC).
  - 2. Outdoors: Totally enclosed, fan cooled (TEFC), weatherproof.
  - 3. Class 1 Division 2 Area: Provide motors totally enclosed, non vented, explosion proof (TEFC-XP).
  - 4. Class 1 Division 1 Area: Provide motors rated for this class.
  - 5. Motors mounted vertically shall be provided with the rain/snow shield made of the same material as the motor frame.
  - 6. Motors shall have drain openings and plugs suitably located for the type assembly being provided.
  - 7. Motor shall be corrosion resistant and severe duty rated per IEEE 841.
- B. TEFC motors shall have a cast iron frame, cast iron end brackets, cast iron bell frame, cast iron conduit box, tapped drain holes (erosion resistant plug for frames 286T(20HP) and smaller and automatic breaker/drain devices for frame 324T(25HP) and larger, and upgraded insulation by additional dips and baked to increase moisture resistance.

## 2.08 BEARINGS

- A. Motors smaller than 1/6 Horsepower: Motor manufacturer's standard bearing is acceptable.
- B. Motors 1/6 Horsepower and Larger: Supply these motors with grease-lubricated antifriction ball bearings conservatively rated for 60,000 hours L10 minimum life of continuous operation under the total radial and thrust loads produced by the actual

combination of motor-driven equipment. Provide each motor with suitable lubrication fittings and pressure relief devices.

- C. Oil Lubricated: If the driven equipment section specifies oil-lubricated bearings for motors, include a suitable sight gauge on each bearing with maximum and minimum levels clearly indicated.
- D. Unless specified otherwise in the driven equipment specifications. Motor bearing life shall be 60,000 hours L10 minimum life whichever is greater.

## 2.09 NAMEPLATES

- A. Main Nameplate: Provide each motor with a stainless steel nameplate meeting the requirements of NEMA MG, and the National Electrical Code, Section 430-7.
- B. Heater Nameplate: When space heaters are furnished, include voltage and wattage on a suitable nameplate.
- C. Bearings Nameplate: When bearings are oil lubricated, include oil type information on a suitable nameplate. Also, indicate bearing data if nonstandard.
- D. Attachment: Attach the nameplates to the motor with stainless steel fastening pins or screws.

## 2.10 IDENTIFICATIONS:

- A. All motors shall be identified as shown on drawings.

## 2.11 CONDUIT BOX

- A. Provide each motor with a conduit box amply dimensioned for the motor lead terminations. Include a grounding lug on motors 1/6 horsepower and larger. Supply a gasket suitable for the motor enclosure type and application.
- B. Provide an oversize box to facilitate wiring terminations. Provide Polaris block type connectors for motors 1/2 Hp and above.
- C. Oversized terminal box shall have a volume greater than or equal to the next standard NEMA size box.
- D. Terminals shall be tinned copper.
- E. Every motor provided shall be hardwired. No motor shall be provided with a cord and a plug.

## 2.12 SPACE HEATERS

- A. Provide space heaters in all motors 25HP and above.
  1. Use heaters hermetically sealed in stainless steel or equivalent corrosion-resistant sheaths.
  2. Heaters shall be rated for 240V, but will be operated at 120 volts.

3. Braze heat-resistant insulated leads to the heater or supply heater with brazed leads and extend to the conduit box.

#### 2.13 MONITORING DEVICES

- A. Motor shall be protected and be supply with necessary monitoring devices per driven equipment specification and contract drawing.

#### 2.14 PAINT

- A. Shall be severe duty and shall have an epoxy coating per IEEE 841.

#### 2.15 ACCEPTABLE MANUFACTURERS

- A. The motor model shall be as listed and manufactured by one or more of the following manufacturers unless otherwise approved by the Engineer.
  1. General Electric.
  2. TECO/Westinghouse
  3. US Motors.

#### 2.16 MOTOR EFFICIENCIES

- A. Three phase motors rated 1 Hp and larger shall be of the NEMA premium efficiency type. Efficiency values shall be based on tests performed in accordance with IEEE Publication No. 112, Method B. Motors with horsepower or rpm's not listed shall conform to comparable standards of construction and materials as those for listed motors.
- B. Motor shall be severe duty rated for industrial application.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. The Contractor shall make all electrical connections to equipment specified. Installation shall be made in compliance with manufacturer's recommendations and the Contract Drawings. If the Contract Drawings or drawings and recommendations from the Manufacturer are not available then installation shall proceed according to the best electrical industry and trade practice.
- B. Properly install and align motors in the locations shown, except motors which are factory mounted on the driven equipment. When the motor and equipment are installed, the nameplate must be in full view.

#### 3.02 LARGER MOTORS

- A. If a motor horsepower rating larger than indicated is offered as a substitute and accepted, provide required changes in conductors, motor controllers, overload relays, fuses, breakers, switches and other related items with no change in the contract price.

### 3.03 TESTING

- A. General: Provide all necessary instruments, labor and personnel required to perform motor inspection and testing.
- B. Inspection: Inspect all motors for damage, moisture, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification and cleanliness, and report any abnormalities to Engineer before energizing.
- C. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads in motor controllers properly rated and all controls in place, energize the equipment at system voltage for operational testing.
- D. As a part of the testing procedure, the Contractor shall prepare a card for each motor, 20 HP and larger, installed on this contract. After each motor has been run to operating temperature, the motor shall be shut down and an insulation resistance shall be made, using a megohmmeter. Make the test immediately after shutdown. Record megohmmeter reading and winding temperature. Correct reading of insulation resistance to 40° C/104°F. Insulation resistance in megohms, corrected to 40° C, shall be at least equal to one (1) megohm for each 1000 volts applied.
- E. Testing shall be in accordance with Division 16.

**ELECTRIC MOTOR QUESTIONNAIRE**  
**Motor Data**

Manufacturer: \_\_\_\_\_ Motor HP: \_\_\_\_\_  
Frame \_\_\_\_\_ Enclosure: \_\_\_\_\_  
Type: \_\_\_\_\_ RPM: \_\_\_\_\_  
Voltage: \_\_\_\_\_ Phases: \_\_\_\_\_ Hertz: \_\_\_\_\_  
Starting Method: \_\_\_\_\_  
Shaft: Size: \_\_\_\_\_  
Insulation Class: \_\_\_\_\_ Duty: \_\_\_\_\_

Full Load AMPS: \_\_\_\_\_ No Load AMPS: \_\_\_\_\_  
Locked Rotor AMPS: \_\_\_\_\_ Locked Rotor Time: \_\_\_\_\_  
Locked Rotor Torque: \_\_\_\_\_ % Breakdown Torque: \_\_\_\_\_  
Locked Rotor KVA/HP: \_\_\_\_\_ Rotor WK2 (lb-ft<sup>2</sup>): \_\_\_\_\_

NEMA Design: \_\_\_\_\_ Service Factor: \_\_\_\_\_ Inrush Current (% of Full Load): \_\_\_\_\_

Max Safe Stalled Time (Seconds): \_\_\_\_\_

Number of Safe Starts Per Day: \_\_\_\_\_ Number of Consecutive Starts: \_\_\_\_\_

\*Full Load Temp Rise, degrees C over 40° C Ambient (at 1.0 S.F.): \_\_\_\_\_

\*Service Factor Temp Rise, degrees C over 40° C Ambient (at 1.15 S.F.): \_\_\_\_\_

\*Limiting Temperature Rise: \_\_\_\_\_

Resistance (at 25° C): \_\_\_\_\_

Bearings: Type/Size \_\_\_\_\_ Life \_\_\_\_\_ Lubrication: \_\_\_\_\_

Exhaust Air (CFM): \_\_\_\_\_ Exhaust Air Temp Rise (°F): \_\_\_\_\_

	<u>EFFICIENCY:</u>	<u>POWER FACTOR:</u>	<u>CURRENT</u>
1.15 S.F. Load:	_____	_____	_____
4/4 Load:	_____	_____	_____
3/4 Load:	_____	_____	_____
1/2 Load:	_____	_____	_____
1/4 Load:	_____	_____	_____

\*Temperature rise measured by embedded detectors and not by resistance.

All Data Fields To Be Completed By The Motor Manufacturer

## PART 1 GENERAL

### 1.01 SCOPE OF WORK

- A. Furnish and install all miscellaneous equipment as shown on the Drawings and as specified herein.

### 1.02 REFERENCE STANDARDS

- A. Equipment enclosures shall have NEMA ratings suitable for the location in which they are installed, as specified in Division 16.

### 1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Division 1, detailed catalog information or drawings describing electrical and physical characteristics of all equipment specified.
- B. Submittal shall be clearly marked showing only equipment provided. Mark through equipment option not provided.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Control Stations
  1. Control stations shall be heavy-duty type, with full size operators. Momentary contact stop buttons shall have a lockout latch that can be padlocked in the open position. Provide an extra contact to monitor the auto position of the switch as shown on the drawings.
  2. NEMA 4X enclosures shall be stainless steel.
  3. NEMA 7 enclosures shall be copper free cast aluminum.
  4. Control stations shall be Allen-Bradley or approved equal.
- B. Wireway
  1. NEMA 4X wireway shall be stainless steel with gasketed, hinged covers and stainless steel type 316 screws.
  2. NEMA 4X shall be Bulletin F-22 as manufactured by the Hoffman Engineering Co. or approved equal.
- C. Control relays
  1. Control relays shall have 120-volt coils, 11 pin tubular octal bases with indicating light, and contacts rated for 10 amps. Furnish 1 N.O. and 1 N.C. spare contacts in addition to those required by the control scheme.
- D. Timing relays

1. Timing relays shall have 120 volt coils, 11 pin base, selectable for on delay or off delay functions, and settable for time delays of 0.05 seconds to 999 minutes with 10 amp contact rating. Relays shall be Square D class 9050 type JCK70 or equal.
- E. Polyethylene Warning Tape
1. Warning tape shall be red metal detectable polyester, 6-in minimum width.
  2. Warning tape legend shall read: "CAUTION: BURIED ELECTRIC LINE BELOW".
- F. Terminal Blocks
1. Terminal blocks shall be 600 Volt, channel mounted, with tubular screw and pressure plate.
  2. Terminal blocks shall be Bulletin 1492 as manufactured by the Allen-Bradley Co. or approved equal.
- G. JIC Boxes for GF Receptacles
1. Furnish all necessary hardware for mounting the heat tape and thermostat.
  2. JIC boxes shall be 6-in by 6-in by 4-in aluminum continuous hinge clamp cover boxes, Hoffman, Catalog No. A-606 CHAL with Type L23 stainless steel type 316 fast operating JIC clamp or approved equal.
  3. Install 1-1/2-in bushings in bottom of box for cord and plug to pass through.
- H. Corrosion Inhibitors
1. All equipment enclosures, terminal boxes, etc, located in a NEMA 4X rated area (where shown on the Drawings) that contains electrical or electronic equipment or terminal strips shall be furnished with an internally mounted, chemically treated corrosion inhibitor pad.
  2. The corrosion inhibitor pads shall be as manufactured by Hoffman Engineering Co.; 3M or approved equal.
- I. Instrumentation Disconnect Switches: Provide a heavy-duty single pole disconnect toggle switch in a weather proof cast enclosure for all field instruments served with electric power. This feature shall be included whether or not shown on drawings.
- J. Fuses, 0 to 600 Volts: Provide a complete set of current-limiting fuses wherever fuses are indicated. Supply a set of six (6) spare fuses of each type and each current rating installed. Utilize fuses that fit mounting specified:
1. For 0 to 600 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1 with time delay, Bussmann Type LPS-RK, Shawmut Type A6D-R, or equal.
  2. For 0 to 250 volt motor and transformer circuits, 0 to 600 amps, UL Class RK-1, Bussmann Type LPN-RK, Shawmut type A2D-R, or equal.
  3. For 0 to 600 volt feeder and service circuits, 0 to 600 amps, UL Class RK-1, Bussmann Type KTS-R, Shawmut Type A6K-R, or equal.
  4. For 0 to 250 volt feeder and service circuits, 0 to 600 amps, UL Class Rd-1, Bussmann Type KTN-R, Shawmut Type A2K-R, or equal.
  5. For 0 to 600 volt feeder and service circuits, 601 to 6,000 amps, UL Class L, Bussmann type KRP-C, Shawmut Type A4BY, or equal.

- K. Indicating Lights: Indicator lamps shall be heavy duty 30mm, industrial type oil tight, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates as required. Unless otherwise specified in each equipment specification lens color shall be green for equipment OFF, red for equipment operating, amber for FAIL and white for power ON/Equipment Stand-by. For all control applications, indicator lamps shall incorporate a push-to-test feature.
- L. Selector Switches: Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30mm, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.
- M. Push Buttons: Push-button, shall be heavy-duty, industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, black field, and legend plates with white markings, as indicated. Button color shall be red for or START and green for STOP. Contact arrangement shall be as required.
- N. E-stop push button: Emergency stop push-button shall be red, non illuminated, mushroom type heavy duty, industrial type with maintained contact, rated for 120 VAC at 10 Amps continuous. Button shall Cutler Hammer HT800 or approved equal.
- O. Combination starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases. Combination Starter is applicable for single motor starter only, refer to common control panel specification for other application.
  - 1. Motor starters shall be 2 or 3 Pole, 1 or 3-phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing except as shown on the drawings. NEMA sizes shall be as required for the horse power shown on the drawings.
  - 2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the drawings. A minimum of one N.O. and N.C. auxiliary contacts shall be provided in addition to the contacts shown on the drawings.
  - 3. Overload relays shall be adjustable ambient compensated and manually reset.
  - 4. Control power transformers shall be sized for additional load where required. Transformer primaries shall be equipped with time-delay fuses.
  - 5. Switches, relays, push buttons shall be as specified under this section.
  - 6. Provide additional protection as shown on contract drawing.
  - 7. Enclosure shall be Nema 4X for outdoor application and Nema 12 for indoor application.
- P. Lighting Contactor
  - 1. Lighting contactor shall be of the electrically operated, mechanically held type mounted in NEMA 1, enclosures (except where noted otherwise on the Drawings)

with number of poles as noted on the Drawings. Operating coils shall be rated for 120 Volts unless otherwise indicated on the Drawings and shall be for momentary operation. Provide with "Hand-Off-Auto" switch on cover where shown on the Drawings.

2. Contactors shall be rated for 20 Amps, 600 VAC and shall be Automatic Switch Co., Bulletin 917 RC, similar by Square D Co.; Cutler Hammer/Westinghouse or approved equal.

Q. Photocells

1. The photocells shall be suitable for power duty with individual fixtures or for pilot duty with contactors as detailed on the Drawings.
2. 120V Photocell shall be Precision P2275 or approved equal.
3. Locking type receptacle shall be Precision M2A or approved equal.

- R. Intrusion Switch: Surface mount aluminum housing contract with armored cable Model 2507 ADL or approved equal

PART 3 EXECUTION - NOT USED

END OF SECTION

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW****PART 1 GENERAL****1.01 SCOPE OF WORK**

- A. Provide, furnish and install all **electrical wire/s, conductor/s and cable/s (WCC)** for all electrical, instrumentation and controls (EIC) work , as applicable and required, to make all electrical system/s complete and satisfactorily operable as specified here-in and designated per the Contract PLANS. Coordinate WCC accordingly for instrumentation and controls (I&C) requirements and applications.
- B. All WCC work shall comply per the National Electrical Code (NEC), all applicable federal, state, and local codes, regulations and ordinances.

**1.02 RELATED SPECIFICATIONS**

- A. DIVISION 16 – Electrical
- B. DIVISION 17 – Process Instrumentation and Controls System, PICS
- C. ALL PROCESS AND/OR MECHANICAL PACKAGED SYSTEM/s --having electrical, instrumentation and control system/s, WCC, components, devices, etc. Reference all applicable and respective, related packaged system/s specification section/s, accordingly.
- D. Other related work as may be designated, required, and/or called for per the CONTRACT DRAWINGS, other related TECHNICAL / EQUIPMENT SPECIFICATIONS and/ or as elsewhere defined or designated.

**1.03 REFERENCES AND STANDARDS**

- A. References and Standards apply in their entirety:
  1. NFPA 70                      National Electric Code
  2. U.L. 44                      Thermoset-Insulated Wires and Cables
  3. U.L. 510                     Polyvinyl chloride, polyethylene, and rubber insulated tape
  4. U.L. 1685                    Vertical Tray Fire Propagation and Smoke-Release test for electrical and fiber optic cables
  5. IECA S-95 /                 Power Cables rated 2000V or less for distribution of electrical  
NECA WC-70                 energy
  6. ASTM B8                    Standard Specification for concentric-lay, stranded copper conductors --hard, medium-hard, and soft
  7. OWNER's Conductor Color Code standard --as designated here-in, 16200, 1.05 D.

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW****1.04 SUBMITTALS**

- A. Submittal/s per product information –catalog data sheets, product ratings, etc. per requirements and compliance per Division 1 – General Provisions, Section 01300, “Submittals”.
- B. Operations and Maintenance (O&M) Manuals –include all approved WCC submittals in the CONTRACT O&M per Section 01730.

**1.05 WIRES, CONDUCTORS AND CABLES COLOR CODING**

- A. Multi-conductor I&C cable/s: Color coding is specified in the multi-conductor cable type specification--as designated per the multi-conductor cable manufacturer.
- B. Power and control WCC: provide single conductor/s with integral insulation pigmentation of the designated and/or required color. EXCEPTION: conductor/s larger than No.6 may be provided with color coding by wrapping black color conductor/s at each end and at all accessible locations with respective/required colored vinyl tape. Where this method of color-coding is used, wrap at least six full overlapping turns of colored vinyl tape around the black color conductor/s covering an area 1-1/2 to 2 inches wide at a visible location.
- C. Phase A, B, and C implies the direction of positive phase rotation for AC power voltage.
- D. Implement OWNER’s authorized conductor color code as designated below:
1. Electric Power WCC compliance per COA, Austin Energy Utility

<u>System voltage/s</u>	<u>Conductor</u>	<u>Conductor Color</u>
a. All systems	Ground	Green
b. 120/240 volts, 1-phase, 3-wire	Hot Leg, L1	Red
	Other Hot Leg, L2	Black
	Neutral, grounded	White
c. 120/208 volts, 3-phase, 4-wire	Phase A	Red
	Phase B	Black
	Phase C	Blue
	Neutral, grounded	White
d. 277/480 volts 3-phase, 3-wire *	Phase A	Brown
	Phase	Yellow
	Phase C	Purple
	Neutral, grounded *	Gray *

\* 3-phase, 4-wire service drop from the power company; neutral is pulled and grounded at first main disconnect only; neutral conductor shall not be installed in electrical power distribution system -- **thereby standard**

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

**practice does not utilize 277V, 1-phase power (line to neutral)**

e.	Motor space heater/s @ 120 volts, 1-phase wrapped	Hot Leg Neutral	Black Black-  w/ white color vinyl tape
f.	DC circuit installed in raceway	Positive (+) Negative (-)	Blue Brown

2. Control Panel WCC shall be rated 41 strand, **tinned copper**, 600V insulation -- rated Type SIS --- WCC color code as follows:

a.	AC controls wire	Red
b.	Annunciator contacts	Yellow
c.	DC controls	Blue
d.	DC (+) power	Red
e.	DC (-) power	Black
f.	AC Hot	Black
g.	AC Neutral	White
h.	PLC/RTU discrete I/O's	Purple

E. NOTE: All WCC shall be color coded and tagged compliance per COA, AWU standard per section 16205 "Wire and Cable Tagging".

**PART 2 PRODUCTS****2.01 GENERAL**

1. Use the manufacturer's name, model or catalog number, if for purpose of establishing standard quality and general configuration desired only.
2. Splices are not approved --exception at lighting fixture/s and convenience receptacles.
3. Samples of all WCC shall be submitted when so requested by the ENGINEER/OWNER for the purpose of determining acceptability of the wire. WCC which have been rejected shall not be used at all. Such rejected WCC shall be removed from OWNER's premises.
4. Multi-conductors cable are NOT APPROVED.

**2.02 CONDUCTORS – 1000 VOLTS (1000V)**

1. Single Conductors at 600V insulation rating:
  1. Unless noted elsewhere or otherwise designated, all power and control WCC shall be 98% conductivity, soft annealed, stranded **copper** with 1000V insulation -- rated Type XHHW-2. Grounding WCC shall be bare, hard annealed, stranded copper.
  2. Use only WCC meeting applicable requirement per UL 44, UL 1685 and IECA S-95-658 (NEMA WC70).

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

3. Power WCC shall not be smaller than #12 AWG, unless otherwise noted on the Contract PLANS.
  4. Control WCC shall not be smaller than #14 AWG, unless otherwise note on the Contract PLANS.
  5. WCC shall be marked every two (2'-0") with the size, type and voltage rating as well as the Manufacturer's name and measurement markers.
  6. Unless otherwise note, conductor size/ampacity rating indicated are based on copper conductor. Do not provide conductor smaller than that designated -- comply per N.E.C.
  7. Approved WCC manufacturers: Anaconda, Cyprus (Rome), General Electric, the Okonite Company, Triangle, or approved equal.
  8. Where flexible power/power and controls cords and cables are supplied, provide same per Type SEOOW rated -- flexible stranded copper conductor/s, 600V insulation rating --with quantity and size conductors as required and/or where designated per the CONTRACT PLANS.
- B. Single Pair Instrumentation Cable – #16 AWG, stranded, twisted, shielded pair (2), 98% conductivity **copper** conductors, 600V insulation and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% pair conductors coverage -- rated Type TC Cable
1. Single pair instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Shall be rated for cable tray, conduit and/or other approved raceway. Minimum temperature rating shall be 90°C dry locations, 75°C wet locations.
- C. Single Triad Instrumentation Cable – #16 AWG, stranded, twisted, shielded triad (3) **copper** conductors, 600V insulation, and a #16 AWG, stranded, tinned copper drain wire with overall aluminum mylar shield overlapped for 100% triad conductors coverage -- rated Type TC Cable
1. Single triad instrumentation cable shall be designed and fabricated for noise rejection for process control, computer and/or data logging applications. Shall have a PVC overall jacket (35 mils) shall be flame retardant, sun light and oil resistant. Suitable for installation in cable tray/s, conduit and/or other approved raceway/s. Minimum temperature rating shall be 90°C dry locations, 75°C wet locations.
- D. Equipment Grounding Wire/Conductor:
1. Provide stranded, copper conductor/s as designated, shown and required per N.E.C. for electrical system grounding and equipment grounding.
  2. Provide conductor/s with green color, 1000V insulation, minimum thickness of 1/32 inch -- rated Type XHHW-2.
- E. All control panel wiring shall be flexible, 41 strand, tinned copper, 600V insulation, Type SIS -- not smaller than #14 AWG, color coded as outlined here-in per section 16200, 1.05, D.2.

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

- F. All WCC shall be new, unused, in good condition and shall be delivered in standard coils, packages or reels. If wire used is different than what is specified, samples of wire shall be submitted for the purpose of determining acceptability of the wire. Wire which has been rejected shall not be used again. Such rejected wire shall be removed from the Owner's premises. Decisions as to the quality of the wire furnished and the acceptance of such wire shall be made by the Owner or his representative.
- G. Power conductors shall not be smaller than No. 12 AWG, except for control and alarm wiring where No. 14 AWG shall be used as minimum size wire when protected by a 15 amp fuse/circuit breaker.
- H. The contractor may, if he deems it necessary or advisable, use larger sized conductors than those required. In no case shall there be a voltage drop greater than that allowed by the N.E.C.
- I. Multi-conductors cable are NOT APPROVED.
- J. WCC splice/s are NOT APPROVED, except for light fixtures and receptacles wiring.

**PART 3 EXECUTION****3.01 GENERAL**

- A. Do not exceed WCC manufacturer's recommendations for maximum pulling tension and minimum bending radii. Pulling compound shall be used. Use only UL listed compound compatible with WCC outer jacket and with the raceway utilized.
- B. Contractor shall provide and install all low voltage (120V, 208V, 240V, 480V, etc.) WCC for power distribution equipment and associated hardware designated and required per the CONTRACT PLANS.
- C. Tighten all screws and terminal bolts using torque type wrenches, and/or drives to tighten to the inch-pound requirements of the NEC and UL.
- D. When single WCC in man-holes, hand-holes, vaults, cable trays and other designated location and/or raceway/s are not wrapped together by some other means, such as arc and fireproofing tapes, bundle throughout their exposed length conductor/s entering from each conduit/raceway with nylon, self-locking, releasable cable ties placed at interval not exceeding 12 inches on-centers.

**3.02 INSTALLATION**

- A. Support all conductors in vertical conduits or raceways in the manner set forth in Article 300-19 of the latest revision of the National Electric Code. Do not use lighting fixtures for raceways or circuits other than parallel wiring of fixtures.
- B. Do not make any splices or taps in any conductor except where absolutely required for 120 volt circuits feeding lights or receptacles. Such splicing may only take place in

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

splice/junction boxes. Elapsed time meters are the only exception to not using a junction box.

- C. Tag all power wiring in all pull boxes, wire ways, motor control center wire ways, panel board wiring gutters, light switch boxes, receptacles, disconnect switches etc. Use flame slip-on type tags, approved for this use, as manufactured by "Raychem", or owner approved equal. See Section 16205, Wire and Cable Tagging Standard for additional requirements.
- D. All interconnect wiring going from one compartment to another, or between two separate pieces of equipment must terminate at a terminal block on each end, i.e. entering and leaving a compartment or piece of equipment.
- E. All wiring passing between cabinets shall be protected by a rubber grommet or approved nipple with bushings.
- F. All wire terminations shall be made with a mechanical compression type lug or terminal specifically designed to accept stranded wire. Do not terminate by wrapping the wire around the screw.
- G. Number 8 AWG and larger wire shall utilize a crimper with a die set to install lugs to the wire.
- H. No more than two wires/ lugs per terminal will be allowed unless ring type lugs are used. A maximum of three wires will be permitted if all wires are using ring lugs.
- I. All current transformer loops shall utilize ring terminals and shorting terminal boards to avoid open circuiting the secondary of a CT.
- J. All wiring run to the front door panel shall have a spiral wrap and tie wrapped to protect wires from being pinched between door and panel. A looped (slack) in conductor/s shall be provided to allow door to open freely.
- K. All main panel wiring shall be run in a raceway such as Panduit. All wiring run from the Panduit to the devices shall be neatly run and tie wrapped. If Panduit is not practical, wires shall be neatly run and tie wrapped.
- L. Equipment grounding wire run in conduit shall have an identifying green covering or green color coding at each end terminations and at junction box or pull box locations along its run length.
- M. Where the capacity of a single feeder is great enough to require parallel conductors in more than one (1) conduit, each conduit must contain the same number and length of conductors in all phases (legs) of the feeder, including any neutral conductors per the N.E.C.
- N. Under no circumstance shall circuits above 600 volts and those below 600 volts be pulled in the same conduit.
- O. Separate low level circuits (such as phone line) from noisy and power circuits by a minimum distance of 1 foot.

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

- P. Bolted and compression connections/terminations for electrical conductors shall be thoroughly cleaned and tinned or covered/sealed with a light, pliable, waterproof film of commercial paste or sealant to prevent oxidation and/or corrosion --- applied to cover complete conductor termination and cover/extend past end of conductor insulation. This is typical/required for Wastewater Facilities and hazardous, moisture and corrosive areas. Acceptable conductor/termination sealant manufacturers are Noalox or approved equal. Include sealant submittal data with WCC submittals.
- Q. Where mechanical assistance is used for pulling conductors, a wire pulling compound, Polywater, or equal, having inert qualities that do not harm the wire insulation or covering shall be free from grease, filings or foreign matter before conductors are pulled. Do not exceed cable Manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- R. Wiring shall be tagged with Raychem Wire Markers, or equal, at panel boards, and all termination points with numbers conforming to the City of Austin Wire and Cable Tagging Standard. Power wiring labels shall be white with black letters.
- S. Lighting and receptacle wiring may use silicone filled spring type wire connectors in approved locations. This applies to lighting and receptacle circuits only.
- T. In no case shall DC voltage circuits and AC circuits be pulled in the same conduit or raceway.

**3.03 FIELD TESTS**

- A. Field test, check and inspect all installed WCC --- comply per requirements per Section 16951 "Calibration and Testing".

**END**

**16200**

**WIRES, CONDUCTORS AND CABLE – 1000V AND BELOW**

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## **PART 1: GENERAL**

The purpose of this specification is to establish a wire tagging method to use on electrical, control and instrumentation systems for the Austin Water Utility.

## **PART 2: PRODUCT**

### **2.1 Wire Tagging**

In general, all wiring shall be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure; box or space designed for wire pulling or inspection and includes pull boxes, manholes, and junction boxes.

Wire tags shall show both origination and destination information to allow for a wire to be traced from point to point in the field. Information regarding its origination shall be shown in parenthesis.

#### **A. Single Conductor Wire Tagging**

The following is the format to use for single conductor wire tags. Tag information to the left refers to the termination point. Tag information in parenthesis refers to point of origination.

**XXXX XX (XXXX-XXXX-XXXXX / XXXX XX)**

**Device Terminal Identifier No. (Equipment Tag No.\*/Device Terminal Identifier No.)**

\* For wiring within a piece of equipment, control panel, junction box, etc., the Equipment Tag No. is **not** required, only the Device Identifier and Terminal Number from the point of origination.

**Example: For a wire connected from Terminal block 1 terminal 23 to relay CR1 terminal 9, the correct tag would be TB1-23(CR1-9) at the terminal block and CR1-9(TB1-23) at the relay.**

#### **B. Device Identifier**

The Device Identifier uniquely identifies a device within a piece of equipment. Examples are: TB1, for terminal block number 1 and CR02, for control relay # 02. For existing equipment, refer to existing device tags or labels and/or equipment documentation. For missing tags or new equipment, refer to the standards developed by EIC Division.

C. Terminal Number

The Terminal Number along with the Device Identifier, identify which specific point in the equipment the wire must be terminated to. Refer to manufacturer's labeling or record drawings for device terminal numbers.

D. Equipment Tag No

The Equipment Tag Number is the physical tag attached to the equipment. For existing equipment, please refer to the Facility in question. For new or missing equipment tags, refer to the EIC Division Standards for tagging standards.

EXAMPLE: Refer to the back of this document for examples on wire tagging within a piece of equipment and between two pieces of equipment.

E. Device Identifier and Terminal Number

The device identifier and terminal number is the same as in a single wire tag above and it describes what device and terminal number the wire is to be terminated to.

## 2.2 Tag Specifications

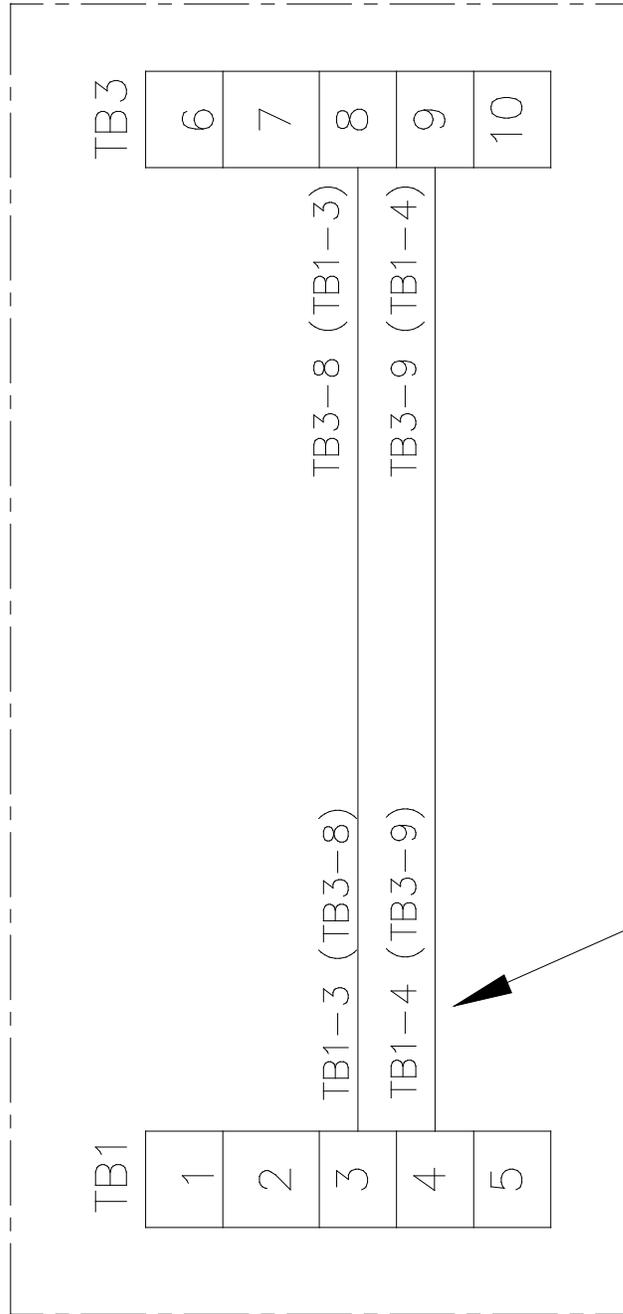
Wire tags shall be **yellow** heat shrink type "Raychem" or Owner approved equal with the tag numbers typed with an indelible marking process. Character size shall be a minimum of 1/8" in height. Hand written tags will **not** be acceptable. Tags shall **not** be heat shrunk unless specifically authorized by owner.

## PART 3: EXECUTION

For deviations from this wire tagging specification, or for cases not covered by these specifications, submit the proposed tagging system to the Electrical Instrumentation and Controls Division staff for approval prior to use.

equipment tag (typ)

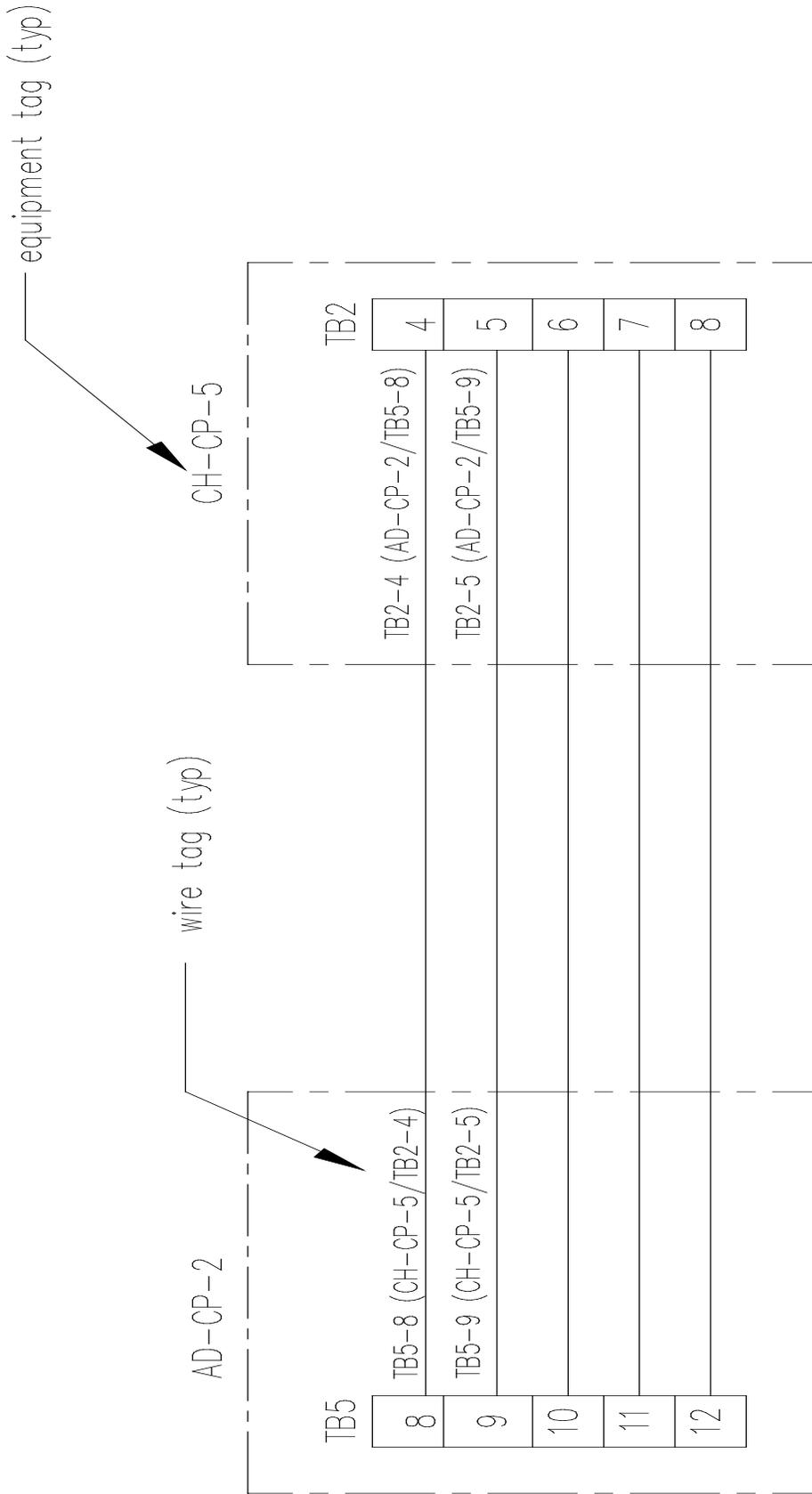
PT-CP-02



wire tag (typ)

**EXAMPLE # 1**

Identification of a Single Conductor within a piece of equipment



EXAMPLE # 2

Identification of a Single Conductor that interconnects two pieces of equipment

## **PART 1: GENERAL**

### **1.01 Scope**

- A. Provide electrical grounding system in accordance with the design **DRAWINGS**, these Specifications and compliance per the N.E.C. Included within this section are furnishing and installing all wire/cable, ground electrodes, ground connections, ground wells/test wells, ground plates, etc. and ground testing report associated with the electrical grounding system.

### **1.02 Related Work**

- A. 01300 Submittals
- B. 01730 Operation and Maintenance Manuals
- C. 16100 Electrical--General
- D. 16110 Raceways, Fittings and Supports
- E. 16130 Boxes and Cabinets
- F. 16140 Wiring Devices
- G. 16200 General Wiring
- H. 16205 Wire and Cable Tagging
- I. 16950 Calibration and Testing
- J. Other related work as may be designated, required, and/or called for per the **CONTRACT DRAWINGS**, other related **TECHNICAL / EQUIPMENT SPECIFICATIONS** and/ or as elsewhere defined or designated.

### **1.03 Standards and References**

Grounding system shall be designed, constructed, and tested according to the latest applicable sections of ANSI, ASTM, IEA, IEEE, NEC, NEMA, NFPA, UL, AEIC, IAE, ISA and ISO9001/9003 standards. Requirements listed in the **DRAWINGS** and specifications are considered additional to the standard requirements listed herein.

### **1.04 Submittals**

- A. Submittals shall be made in accordance with the requirements of Section 01300, "Submittals" and Section 16100 "Electrical - General". In addition the following specific information here in shall be complied.
- B. Submittal Data: Submit the following data for ground system, accessories and appurtenances:

1. Manufacturer and model number (s) for all system components furnished and installed.
  2. Submit data for grounding equipment--ground rods; ground wire/cable; procedure, materials and equipment for ground connections--i.e. thermal welds—exothermic, thermite weld by Thermoweld and/or Cadweld (brand names); ground well terminations; ground test well terminations; ground to steel structure connections; etc.
- C. Submittal data shall be sufficient to determine compliance, either meet or exceed these specifications.

OPERATIONS & MAINTENANCE MANUALS (O & M MANUALS) SUBMITTALS

- D. O & M Manuals: Furnish complete documentation and quantity per Section 01730 of the **CONTRACT**. As a minimum, O & M Manuals shall provide the following:
1. All data per SUBMITTALS as designated here-in and all grounding testing data and report/s.

**1.05 Delivery, Storage and Handling**

- A. Delivery, storage, and handling shall be in accordance with Section 01610, "Delivery, Storage and Handling".
- B. Grounding equipment, materials, supplies, etc. shall be stored off the ground and keep dry at all time, up to time of its installation. Handle with care to prevent damage, loss or compromise of its packing material.

**1.6 Warranty**

- A. CONTRACTOR shall guarantee and warrant the installed electrical ground system as integral part of the complete electrical system and/or as designed and designated. Provide written electrical ground system warranty as part of the warranty for the complete electrical system.

**PART 2: PRODUCTS**

**2.1** Ground electrode (ground plate) shall be ERICO copper plate with terminated, welded pigtailed @ 16 gauge, 24" x 24" (minimum) or approved equal or as designated per the design **DRAWINGS**. Contractor shall use ground enhanced material (GEM) for backfilling around ground plates.

**2.2** Ground connection and wire/cable shall be as follows:

- A. Below grade: Cadweld, Burndy Thermoweld, or approved equal thermite reaction welding system ground connection.
- B. Above grade: Burndy Type GAR, GB, GBM or GG connector as required or approved equal. Where applicable and/or as designated, install thermite weld ("Thermoweld, Cadweld, etc.") ground cable connection to all designated equipment and/or metal structural grounding above grade.

- C. Ground wire shall be green color insulation, stranded, copper conductor XHHW-2 rated for raceways/conduits and bare, stranded, annealed copper wire/conductor for underground ground grid, ground loop/s, etc. Ground wire shall be sized as designated on the designed **DRAWINGS** compliance per N.E.C., not less than #6 AWG service ground and not less than #2/0 AWG bare copper ground for underground ground grid, ground loop/s, etc.
- D. Ground well/s shall be precast box with accessible cast iron lid. Lid shall read "Ground Well" on top. Brooks precast box, model # 3-RT, not less than 8"x8"x8" deep or approved equal—see applicable ground well detail per the Contract Drawings. Ground well/s located in driveway shall have AASHO H-20 traffic load *rating*.
- E. Ground test well/s shall be precast box with accessible cast iron lid. Lid shall read "Ground Test Well" on top. Brooks precast box, model # 3-RT or approved equal—not less than 8"x8"x8" deep; see applicable ground test well detail per the Contract Drawings. Ground test well/s located in driveway shall have AASHO H-20 traffic load rating.

### **PART 3: EXECUTION**

#### **3.1 Ground Grid**

- A. Install the number of ground electrodes, ground wells and ground test wells as shown on the **DRAWINGS**.
- B. Use a thermal fusion process --Burndy Thermoweld, Cadweld, or approved equal to make ground grid connections to ground electrodes and at any joint or connection which will be inaccessible --buried/concealed after installation/construction. Coat connections with Koppers Bitumastic No. 505 or equivalent coal tar pitch extended to 3 inches of conductor or full length of exposed ground conductor coverage to and overlapping conductor's insulation where insulated ground conductor is employed. Do not cover/backfill below grade/concealed connections until each connection has been inspected by the **ENGINEER / OWNER** or electrical construction inspector. Where applicable and/or as designated, ditto this process for above grade ground connections to designated equipment and to metal structural ground connections.
- C. Provide minimum of one ground test well accessible for ground grid testing and connection inspection. Utilize a ground test well with removable cover for accessibility from finished grade—comply as specified here-in.

#### **3.2 General Equipment Grounding**

- A. Ground all electrical equipment, lights, receptacles, etc., with a separate equipment ground wire/conductor installed in the conduit with the power conductors. Provide/install ground wire/conductor in all conduit/raceway compliant per N.E.C.
- B. Install grounding system electrically and mechanically continuous throughout. Do not bond to the system neutral except at the service transformer or service main disconnect switch or breaker.
- C. Install a bonding jumper from the grounding lug on each conduit to the ground bar or bus.

**16550**  
**GROUNDING**

- D. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made. Size general equipment ground wire not less than #10 AWG, stranded copper; major equipment–panelboard, motors, compressors, etc. ground wire size shall comply per N.E.C. for equipment grounding and/or per the design **DRAWINGS**.
- E. Provide a PVC sleeve where bare ground wire passes through concrete slab at or above ground level, where applicable.
- F. Connect ground wires entering outlet boxes in such a manner that removal of the receptacle will not interrupt the continuity of the grounding circuit. A grounding screw attached to the box, and used for no other purpose, may be used to accomplish this.
- G. Install a separate ground rod for lighting poles. Ground rod to be brought up through light pole foundation into base of light pole accessible via pole base handhole. Make lighting pole ground connection to the ground rod inside the pole base (See **DRAWINGS** detail).
- H. Ground system “resistance” shall measure not more than 2.0 ohms power and not more than 1.0 ohm for instrumentation / communications / computer, network system. Ground system shall be calibrated and tested; provide ground system test data and report/s –compliance per Section 16950 “Calibration and Testing”. Ground system test data and report/s shall be included part of project O & M Manual.

**PART 4: MEASUREMENT AND PAYMENT**

No separate measurement or payment for work performed under this Section. Include the cost of same in the **CONTRACT** price bid for the project of which this is a component part.

**END**

## **PART 1: GENERAL**

### **1.1 Scope**

Furnish and install disconnect switches as indicated on the Drawings and specified herein. All switches are to be NEMA Heavy Duty Type HD, fused or non-fused as shown on the drawings. U.L. label and meeting Fed. Spec. WS 865c and NEMA Standard KSI-1975.

### **1.2 Related Specifications**

None

### **1.3 Submittals**

- A. Submittals shall be made in accordance with the requirements of Section WW-01300, "Submittals".
- B. Operations and Maintenance (O&M) Manuals shall be made in accordance with the requirements of Section WW-01730.

### **1.4 Acceptable Manufacturers**

Furnish units manufactured by General Electric, Siemens, Square D, Cutler Hammer or approved equal.

## **PART 2: PRODUCTS**

### **Construction**

#### **2.1 Disconnect Switches**

All switches are to have switch blades which are fully visible in the "OFF" position when the door is open. Switches are to be of dead-front construction with permanently attached arc suppressers hinged or otherwise attached to permit easy access of line-side lugs without removal of the arc suppresser. Lugs to be front removable and U.L. listed for copper cables. All current-carrying parts to be plated through electrolytic processes. Each switch to have a grounding lug for equipment ground wire connection rated for 75°C Copper.

Switches to have load break, quick-make and quick-break operating mechanism and handles with provision for padlocking in either position. The locking provisions shall be such that the padlock directly interferes with the operating handle and is fully visible. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door in an "ON"

position or closing of the switch mechanism with the door open. Switches shall be horsepower rated for 250 Volts AC or DC or 600 Volts AC as required for their service. All switches shall meet the requirement and fuse ratings as shown on drawings.

Fuses shall be equal to Bussman or Chase-Shawnut, or approved equal, dual element type. Size shall be as shown on drawings.

## **2.2 Enclosed Circuit Breaker**

Circuit Breaker shall be three pole, 600 volt rated, with a maximum current capacity as shown on the plans. RMS symmetrical short circuit rating shall be as shown on the plans, but in no case shall it be less than 42,000 AIC. The circuit breaker shall be manufactured by G.E., Cutler Hammer or Square D Company.

## **2.3 Enclosures**

Switches and enclose Breaker enclosures to be NEMA 4X 316 stainless steel. They shall be pad-lockable in on and off positions.

## **PART 3: EXECUTION**

### **Installation**

Install switches/ breakers at 4'-0" above the finished floor unless otherwise noted.

## PART 1 GENERAL

### 1.01 WORK INCLUDED

- A. Furnish and install a functional control panel to operate the control system as specified in the detailed mechanical equipment requirements of this Section and the purchase specification.
- B. Obtain all required control descriptions and data from the detailed mechanical equipment requirements to this Section, the System Description and the control schematic diagrams on the Electrical Contract Drawings.
- C. Provide control system engineering to produce custom elementary drawings showing interwiring and interlocking with remote devices.
- D. All control devices, unless specified otherwise, shall be mounted in the control panel.
- E. This section includes control panels supported by equipment Manufacturer's to manually or automatically operate the mechanical equipment.

### 1.02 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers (IEEE).
- B. National Electrical Manufacturers Association (NEMA).
- C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

### 1.03 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300, shop drawings and product data. The documents submitted shall contain but not be limited to the following:
  - 1. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section. Furnish complete Bill of Materials indicating Manufacturer's part numbers.
  - 2. Power and control schematics including external connections. Show wire and terminal numbers and color coding.
  - 3. Instruction and replacement parts books.
  - 4. Certified shop test reports.
  - 5. As-built final drawings.
  - 6. Field tests and inspection reports.

### 1.04 QUALITY ASSURANCE

- A. A factory authorized service and parts organization shall be able to respond to any service call for the project within 8 hours. Provide the name and address of the factory authorized service and parts organization nearest to the project location at the time of the bid.

- B. Equipment components and devices shall be UL labeled to the extent possible wherever UL standards exist for such equipment.
- C. The control panel Manufacturer shall demonstrate at least three years of continuous field operating experience in control panel design and fabrication. Submit customer/user list with telephone numbers, addresses and names of customer/user representatives.

#### 1.05 SYSTEM DESCRIPTION

- A. Refer to the detailed mechanical equipment specifications for description of system operation.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Package the control panel for maximum protection during delivery and storage.
- B. Store the control panel indoors in a clean, dry, heated storage facility until ready for installation. Do not install the control panel in its final location until the facilities are permanently weather tight. Protect the control panel at all times from exposure to moisture, chemicals, hydrogen sulfide and chlorine gas.

#### 1.07 WARRANTY

- A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for a period no less than the controlled equipment warranty. Warranty shall be two (2) years from date of substantial completion.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. The control panel shall consist of a main circuit breaker, a combination motor circuit protector (MCP), magnetic starter and overload relay for each motor, a 120 volt control power transformer with two fuses on the primary and one fuse on the secondary. All control components shall be mounted in one common enclosure. Control switches shall be provided to operate each motor either manually or automatically.

#### 2.02 RATING

- A. The control panel shall operate on a power supply as indicated on drawings.
- B. The overall withstand and interrupting rating of the equipment and devices shall not be less than 35000 amperes R.M.S, symmetrical at 480 Volts. All circuit breakers and combination motor starters shall be fully rated for the above fault current interrupting capacity. Series connected short circuit ratings will not be acceptable.
- C. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels.
- D. The control panel shall meet all applicable requirements of the National Electrical Code.

- E. The control panel enclosure shall be in accordance with the electrical area classification indicated on the Electrical Contract Drawings.

## 2.03 COMPONENTS

- A. The main circuit breaker shall be a thermal-magnetic molded case breaker, Type FCL or provide a main fused disconnect rated 35 kAIC to limit the let thru current. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position.
- B. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to the motor.
- C. Motor starters shall be provided with motor circuit protectors and equipped to provide under-voltage release and overload protection on all three phases.
  - 1. Motor starters shall be 2 or 3 Pole, 1 or 3-phase as required, 60 Hz, 600 Volt, magnetically operated, full voltage non-reversing except as shown on the drawings. NEMA sizes shall be as required for the horsepower shown on the drawings.
  - 2. Each motor starter shall have a 120 Volt operating coil and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the drawings. A minimum of one N.O. and N.C. auxiliary contacts shall be provided in addition to the contacts shown on the drawings.
  - 3. Overload relays shall be adjustable ambient compensated and manually reset.
  - 4. Control power transformers shall be sized for additional load where required. Transformer primaries shall be equipped with time-delay fuses.
- D. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein, as required by the detailed mechanical equipment requirements, Division 16, Division 17 and as shown on the Drawings.
- E. All operating control devices and instruments shall be securely mounted on the exterior door. All controls shall be clearly labeled to indicate function and shall be in accordance with the electrical area classification indicated on the Electrical Drawings.
  - 1. Indicator lamps shall be heavy duty, 30 mm industrial type oil tight, high-visibility LED, full voltage type. Units shall have screw on plastic lenses and shall have factory engraved legend plates. Unless otherwise specified in each equipment specification lens color shall be green for equipment OFF, red for equipment operating, amber for FAIL and white for power ON/Equipment Stand-by. For all control applications, indicator lamps shall incorporate a push-to-test feature.
  - 2. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, MOTOR SELECTOR, LEAD-LAG, etc) shall be heavy-duty 30 mm, oil tight, industrial type with contacts rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Operators shall be black knob type. Units shall have the number of positions and contact

arrangements, as required. Units shall be single-hole mounting, accommodating panel thicknesses from 1/16-in minimum to 1/4-in maximum.

3. Push-button, shall be heavy-duty, 30 mm, oil tight industrial type with momentary or maintained contacts as required, rated for 120 VAC at 10 Amps continuous. Units shall have standard size, white field, and legend plates with black markings, as indicated. Button color shall be red for START and green for STOP. Contact arrangement shall be as required.
  4. E-stop push button shall be red, non illuminated, mushroom type heavy duty, industrial type with maintained contact, rated for 120 VAC at 10 Amps continuous. Button shall Cutler Hammer HT800 or approved equal.
- F. A six digit, non-resetable elapsed time meter shall be connected to each motor starter.
- G. A failure alarm with horn and beacon light shall be provided as required by contract document. Silence and reset buttons shall be furnished.
- H. The control panel shall be provided with an SPD Unit on the load side of the main circuit breaker. SPD shall be rated 65Ka per mode. SPD shall be provided with over-current disconnecting mean in order to safely remove the SPD while panel is operating.
- I. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 VAC and 10 Amps continuous.
- J. An alternator shall be provided to sequence motors as required by contract document.
- K. Control relays shall have 120-volt coils, 11 pin tubular octal bases with indicating light, and contacts rated for 10 amps. Furnish 1 N.O. and 1 N.C. spare contacts in addition to those required by the control scheme.
- K.L. L. Timing relays shall have 120 volt coils, 11 pin base, selectable for on delay or off delay functions, and settable for time delays of 0.05 seconds to 999 minutes with 10 amp contact rating. Relays shall be Square D class 9050 type JCK70 or equal.
- L.M. Panel mounted timers shall be flush mounted, plug-in type with ranges as shown on the Drawings, or as required by the detailed mechanical equipment specifications and Division 17.
- M.N. Specific control devices, control descriptions and other data are specified under the detailed specification for the mechanical equipment with which the control panel is supplied.
- 2.04 ENCLOSURE TYPES
- A. The control panel specified herein shall be rated NEMA 12 for panels located indoor, NEMA 4X 316 Stainless Steel for panels located outdoors.
  - B. Steel enclosures shall be 12 gauge and constructed with continuously welded seams. The panel door(s) shall have continuous hinge with quarter turn latches and neoprene gasket. Door clamps shall be provided. The enclosures shall be Hoffman Concept or an approved equal.
  - C. The enclosure shall incorporate a removable back panel on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs. The

enclosure door shall be interlocked with the main circuit breaker by a door mounted operating mechanism. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

- D. Print storage pockets shall be provided on the inside of the panel.
- E. Overload tables shall be laminated and adhered to the inside of the door.

#### 2.05 NAMEPLATES MARKINGS AND IDENTIFICATION

- A. Provide 2-in by 5-in, nominal, engraved phenolic master nameplate on the control panel fastened with stainless steel type 316 screws or rivets. Nameplate shall be white with black core, 3/8-in high lettering and shall indicate equipment designation as shown on the Drawing.
- B. Provide legend plates or 1-in by 3-in engraved nameplates with 1/4-in lettering for identification of door mounted control devices, pilot lights and meters.
- C. Provide permanent warning signs as follows:
  - 1. "Danger- High Voltage- Keep Out" on all doors.
  - 2. "Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on main power disconnect.
  - 3. Arc Flash labels shall be provided for every 480V panel.

#### 2.06 CONDENSATION HEATERS

- A. A strip heater shall be mounted inside the control panel.
  - 1. Heater shall be rated 240V, but operated at 120V, single phase, 150 watts, with rust resisting iron sheath.
  - 2. A control thermostat shall be mounted inside the control Panel.
  - 3. The strip heater terminals shall be guarded by a protective terminal cover.
  - 4. High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be No. 12 AWG stranded, nickel-plated copper with Teflon glass insulation.

#### 2.07 WIRING

- A. All power and control wire shall be flexible 41 strand #14 AWG, 600 Volt insulation type SIS tinned copper, color coded as outlined in specification SS 16200 "General wiring methods" and shall be of the sizes required for the current to be carried, but not smaller than No. 14 AWG. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover.
- B. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks.
- C. All control panel wiring shall be numbered at both ends with type written heat shrinkable wire markers. The numbers used shall be as specified in section SS 16205, Wire Tagging.

## 2.08 TERMINAL BLOCKS

- A. Terminal blocks shall be 600 Volt rated, rail mounted capable of accepting # ~~22-24~~ to # ~~8-12~~ wires. Terminal blocks shall be ~~Westinghouse type TBA, Allen Bradley 1492 series~~ rated for a minimum of ~~25-16~~ amps or equal. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
- B. Wires shall be terminated to the terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated.
- C. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20 percent spare terminals.
- D. Provide an intrinsically safe ground terminal bar isolated from the control panel enclosure. Provide 20 percent spare terminals but not less than two spare terminals.
- E. Terminal points for current transformer leads shall be provided with a shorting bar.

## 2.09 SHOP TEST

- A. Perform Manufacturer's standard production testing and inspection in accordance with NEMA and ANSI standards.

## PART 3 EXECUTION

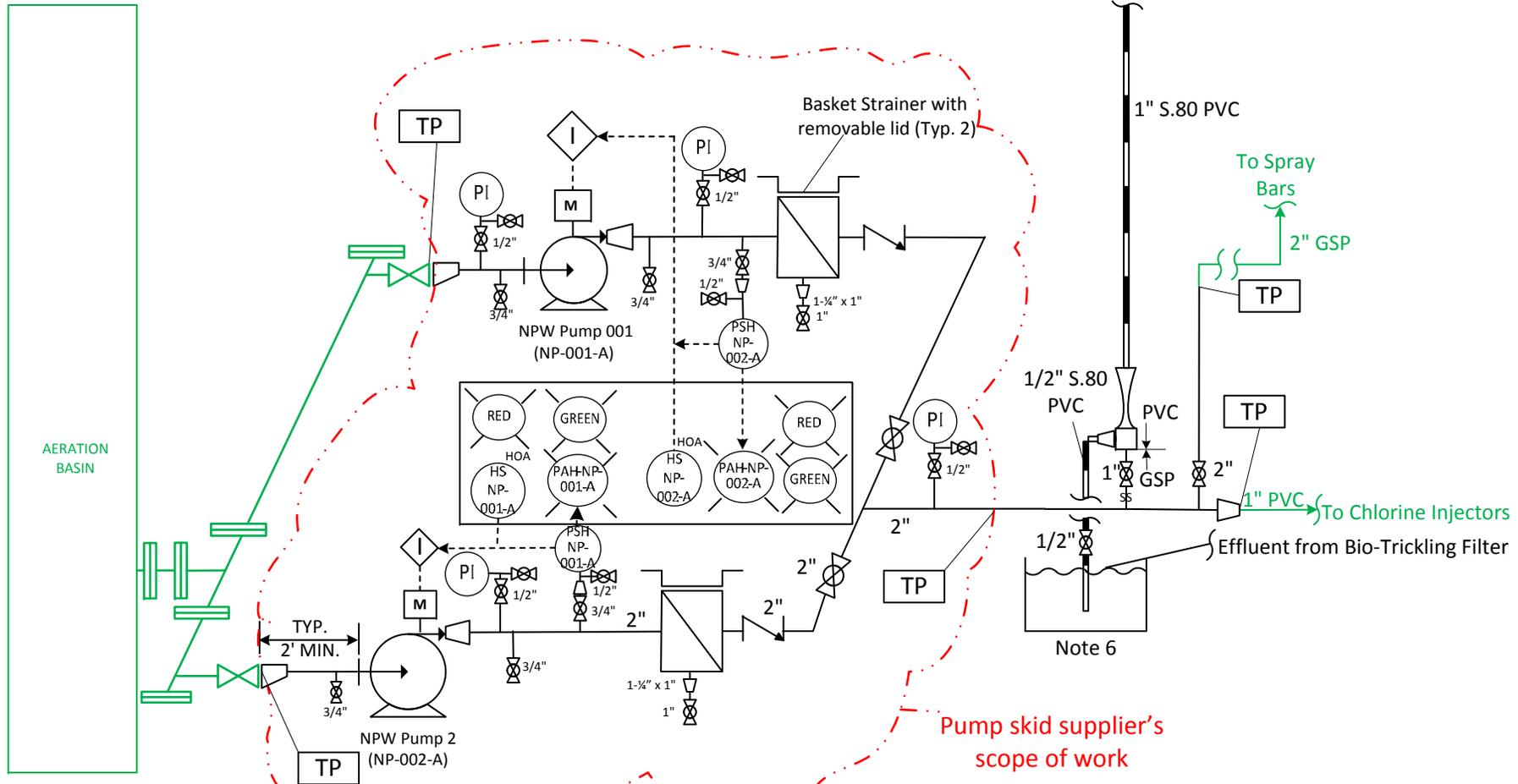
### 3.01 INSTALLATION

- A. Repaint any damage to factory applied paint finish using touch-up paint furnished by the control panel Manufacturer.
- B. Any work not installed according to the Drawings and this Specification shall be subject to change as directed by the Engineer. No extra compensation will be allowed for making these changes.

### 3.02 FIELD TESTING

- A. Check mechanical interlocks for proper operation. Make any adjustments required.
- B. Adjust motor circuit protectors and voltage trip devices to their correct settings.
- C. Install overload heaters per actual motor nameplate currents.
- D. Adjust motor circuit protectors for actual motor nameplate currents.
- E. In the event of an equipment fault, notify the Engineer immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the Contractor, the Engineer and the control panel Manufacturer's factory service technician. Repair or replace the equipment as directed by the Engineer prior to placing the equipment back into service.

END OF SECTION



**LEGEND:**

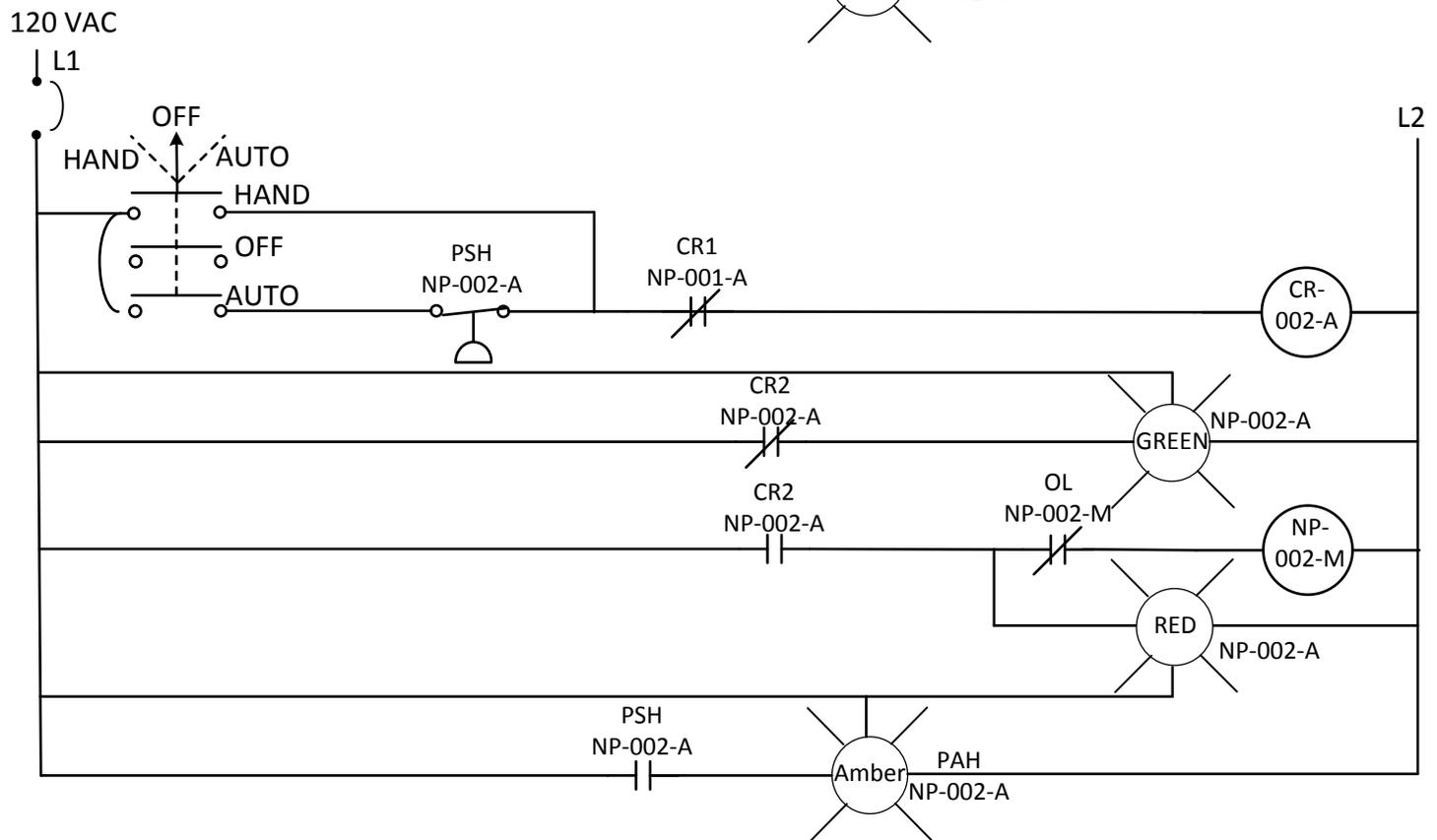
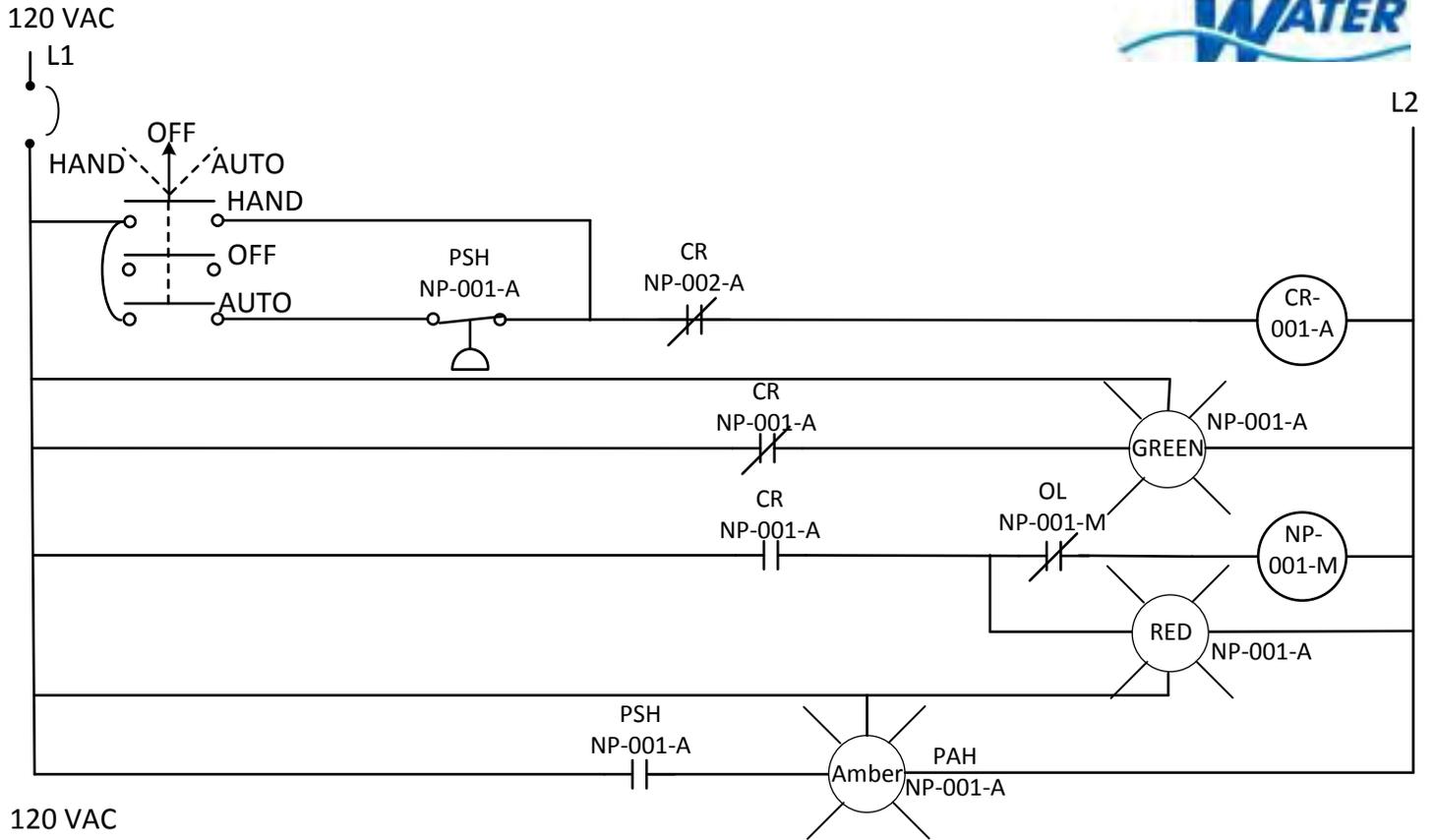
	Tie Point		EXISTING
	Ball Valve		PROPOSED
	Check Valve		PROPOSED PVC
	Air Release Valve		
	Gate Valve		
	Y-strainer		
	Eductor		
	Conc. Enlarger/ Reducer		
	Ecc. Reducer		
	FSL		Flow Switch Low
	PAH		Pressure Alarm High
	PSH		Pressure Switch High
	PI		Pressure gage
	M		Motor
	I		Interlock
	O/O		On/Off
	GSP		Galv. steel pipe
	SS		Service Saddle

**NOTES:**

1. Tie point for mechanical Scope of Work is discharge side of existing suction isolation valves (By Installation Contractor).
2. Electrical scope includes demolition of both existing NPW pumps and local disconnects. Pull new conductors to spare 480V starter buckets in MCC. Install new breakers to match new pump motors.
3. Field route new pipe to tie points and to catchment barrel for bio-trickling filter effluent. Install unions for easy removal of threaded components.
4. Embed bottom half of 55-gallon plastic barrel below pipe to catch effluent from bio-trickling filter.
5. Eductor: Grainger item number 5NAU3 or equal.
6. All new field fabricated piping shall be galvanized steel except for eductor suction and discharge, which shall be PVC.
7. Drill galvanized steel piping for connections. Use nylon-coated ductile iron u-bolt service saddles to make size reductions. For drain valves, install service saddles in low spots (but allow enough height to allow connection of water hose). Romac model 202NU service saddles or equal.

**LOST CREEK WWTP – NPW PUMP REPLACEMENT SCHEMATIC**

Scale: None



- NOTES: 1. The duty pump set to AUTO will run while the other pump set in AUTO will not start until the running pump shuts down on high pressure. After duty pump has shut down on high pressure, Operator will move switch from AUTO to OFF, clean basket strainer and afterward move switch from OFF back to AUTO, allowing former duty pump to become the standby pump. Standby pump will not operate, even in HAND until duty pump is turned OFF or shuts down on high pressure.
2. Status and alarm lights shall have push-to-test functionality.

**LOST CREEK WWTP – NPW PUMP CONTROL SCHEMATIC**

Scale: None

February 2015



**NEW NPW SKID SHALL FIT  
IN PLACE OF EXISTING  
PUMPS, WHICH WILL BE  
DEMOLISHED BY OTHERS**

**TIE POINT**