

SECTION 26 05 01
ELECTRICAL – REISSUED WITH ADDENDUM 1

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
1. American Association of State Highway Transportation Officials (AASHTO).
 2. ASTM International (ASTM):
 - a. A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
 - b. A240/A240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
 - c. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
 - d. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
 - e. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
 3. Electronic Industries Association (EIA/TIA): 569, Commercial Building Standard for Telecommunications Pathways and Spaces.
 4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - b. PC62.41.1, Draft Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
 - c. 114, Standard Test Procedures for Single-Phase Induction Motors.
 5. International Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
 6. National Electrical Contractor's Association, Inc. (NECA): 1, Standard Practices for Good Workmanship in Electrical Contracting.
 7. National Electrical Manufacturers Association (NEMA):
 - a. C80.1, Rigid Steel Conduit-Zinc Coated.
 - b. C80.3, Electrical Metallic Tubing-Zinc Coated.
 - c. C80.6, Intermediate Metal Conduit-Zinc Coated (IMC).
 - d. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
 - e. CC1, Electrical Power Connectors for Substations.

- f. ICS 1, Industrial Control and Systems: General Requirements.
- g. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated Not More Than 2000 Volts AC or 750 Volts DC.
- h. MG 1, Motors and Generators.
- i. PB 1, Panelboards.
- j. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- k. ST 20, Dry Type Transformers for General Applications.
- l. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
- m. TC 3, PVC Fittings for Use with Rigid PVC Conduit and Tubing.
- n. WC 55, Instrumentation Cables and Thermocouple Wire.
- o. WC 70, Standard for Non-Shielded Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
- p. WD 1, General Color Requirements for Wiring Devices.
- 8. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
- 9. UL:
 - a. 1, Flexible Metal Conduit.
 - b. 6, Electrical Rigid Metal Conduit—Steel.
 - c. 13, Power-Limited Circuit Cables.
 - d. 44, Thermoset Insulated Wires and Cables.
 - e. 62, Flexible Cord and Fixture Wire.
 - f. 67, Panelboards.
 - g. 98, Enclosed and Dead-Front Switches.
 - h. 360, Liquid-Tight Flexible Steel Conduit.
 - i. 486A, Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - j. 486C, Splicing Wire Connectors.
 - k. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - l. 508, Industrial Control Equipment.
 - m. 510, Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
 - n. 514B, Fittings for Cable and Conduit.
 - o. 651, Schedule 40 and 80 PVC Conduit.
 - p. 797, Electrical Metallic Tubing.
 - q. 854, Service-Entrance Cables.
 - r. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
 - s. 943, Ground-Fault Circuit Interrupters.
 - t. 1059, Terminal Blocks.
 - u. 1242, Intermediate Metal Conduit.
- 10. Pacificorp Electric Service Requirements Manual

1.02 DEFINITIONS

- A. AHJ: Authority Having Jurisdiction.
- B. MCOV: Maximum Allowable Continuous Operating Voltage.
- C. SVR: Surge Voltage Rating.
- D. TVSS: Transient Voltage Surge Suppressor.

1.03 SUBMITTALS

A. Action Submittals:

- 1. Pedestal-type service entrance and combined metering equipment.
- 2. Boxes and device plates.
- 3. Junction and pullboxes.
- 4. Wiring devices.
- 5. Circuit breakers and switches.
- 6. Motor-rated switches.
- 7. Control devices, terminal blocks, and relays.
- 8. Support and framing channels.
- 9. Nameplates and nameplate schedule.
- 10. Conduit, fittings, and accessories.
- 11. Conductors, cable, and accessories.
- 12. Motors: Nameplate data, detailed information on any special features.
- 13. Grounding materials.
- 14. Pedestal-Type RTU Cabinets and Local Control Panels: Arrangement drawings, schematic and wiring diagrams, bill of materials, nameplate schedule, manufacturer information on components.
- 15. Luminaires.

B. Informational Submittals:

- 1. Factory test reports.
- 2. Field test reports.
- 3. Signed permits indicating Work is acceptable to regulatory authorities having jurisdiction.
- 4. Operation and Maintenance Data:
 - a. As specified in Section 01 78 23, Operation and Maintenance Data.
 - b. Provide for all equipment, as well as each device having features that can require adjustment, configuration, or maintenance.
 - c. Minimum information shall include manufacturer's preprinted instruction manual, one copy of the approved submittal

information for the item, tabulation of any settings, and copies of any test reports.

1.04 APPROVAL BY AUTHORITY HAVING JURISDICTION

- A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.
- B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.

PART 2 PRODUCTS

2.01 GENERAL

- A. Products shall comply with all applicable provisions of NFPA 70.
- B. Like Items of Equipment: End products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.
- C. Equipment and Devices Installed Outdoors or in Unheated Enclosures: Capable of continuous operation within ambient temperature range of minus 30 degrees F to 110 degrees F.
- D. Equipment Finish:
 - 1. Manufacturer's standard finish color, except where specific color is indicated.
 - 2. If manufacturer has no standard color, finish equipment in accordance with Section 09 90 00, Painting and Coating.

2.02 SERVICE ENTRANCE EQUIPMENT AND METERING

- A. Equipment, installation arrangement, and scope of work shall be provided in accordance with requirements of Rocky Mountain Power, as outlined in the latest edition of the Pacificorp Electric Service Requirements Manual.

2.03 OUTLET AND DEVICE BOXES

- A. Cast Metal:
 - 1. Box: Cast ferrous metal.

2. Cover: Gasketed, weatherproof, and cast ferrous metal with stainless steel screws.
3. Hubs: Threaded.
4. Lugs: Cast Mounting.
5. Manufacturers and Products, Nonhazardous Locations:
 - a. Crouse-Hinds; Type FS or FD.
 - b. Appleton; Type FS or FD.
6. Manufacturers and Products, Hazardous Locations:
 - a. Crouse-Hinds; Type GUA or EAJ.
 - b. Appleton; Type GR.

2.04 JUNCTION AND PULL BOXES

- A. Outlet Boxes Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.
- B. Conduit Bodies Used as Junction Boxes: As specified under Article Conduit and Fittings.
- C. Large Box In Vaults:
 1. NEMA 250, Type 4.
 2. Box: Fiberglass, with white enamel painted interior mounting panel.
 3. Cover: Hinged with clamps.
 4. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
 5. Manufacturers:
 - a. Hoffman Engineering Co.
 - b. Robroy Industries.

2.05 WIRING DEVICES

- A. Switches:
 1. NEMA WD 1 and FS W-S-896.
 2. Industrial grade, totally enclosed, ac type, with quiet tumbler switches and clamp type terminals for back wiring.
 3. Capable of controlling 100 percent tungsten filament and fluorescent lamp loads.
 4. Rating: 20 amps, 120/277 volts.
 5. Color: White.
 6. Automatic grounding clip and integral grounding terminal on mounting strap.
 7. Manufacturers and Products:
 - a. Leviton; 1221 Series.
 - b. Bryant; 4901 Series.
 - c. Hubbell; 1221 Series.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Simplex and Duplex, listed Class A to UL Standard 943, tripping at 5 mA.
2. Color: White.
3. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps.
4. Size: For 2-inch by 4-inch outlet boxes.
5. Standard Model: NEMA WD 1, with screw terminals and provisions for testing.
6. Impact resistant nylon face.
7. Manufacturers:
 - a. Bryant.
 - b. Hubbell.
 - c. Leviton.

2.06 DEVICE PLATES

A. General: Sectional type plates not permitted.

B. Metal:

1. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
2. Finish: ASTM A167, Type 302/304, satin.
3. Mounting Screw: Oval-head, finish matched to plate.

C. Cast Metal:

1. Material: Copper-free aluminum, with gaskets.
2. Screw: Oval-head stainless steel.

D. Weatherproof:

1. For Receptacles, Wet Locations:
 - a. Impact-resistant, GFCI type, nonmetallic, single-gang, horizontal-mounting, providing, while in-use, NEMA 3R rating.
 - b. Stainless steel mounting and hinge hardware.
 - c. Lockable, paintable.
 - d. Manufacturers:
 - 1) Carlon.
 - 2) Leviton.
2. For Switches:
 - a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
 - b. Mounting Screw: Stainless steel.
 - c. Manufacturers and Products:

- 1) Crouse-Hinds; DS-181 or DS-185.
- 2) Appleton; FSK-1VTS or FSK-1VS.

2.07 COMBINED METER PEDESTAL WITH INTEGRAL LOADCENTER

- A. NEMA PB 1, NFPA 70, and UL 67.
- B. Loadcenter and Circuit Breakers: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- C. Short-Circuit Current Equipment Rating: Fully rated; series connected unacceptable.
- D. Utility meter socket shall comply with Pacificorp Electric Service Requirements Manual, Section 10.3, 10.4, and 10.5.
- E. Rating: Applicable to a system with available short-circuit current of the indicated value amperes rms symmetrical at 120/240 volts.
- F. Cabinet:
 1. NEMA 250, Type 3R.
 2. Material: Code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
 3. Wiring Gutter: Minimum 4-inch square; both sides, top and bottom.
 4. Front: Fastened with adjustable clamps.
 - a. Trim Size: As required by mounting.
 - b. Finish: Manufacturer's standard.
 5. Interior:
 - a. Factory assembled; complete with circuit breakers.
 - b. Spaces: Cover openings with easily removable metal cover.
 6. Door Hinges: Concealed.
 7. Locking Device:
 - a. Flush type.
 - b. Doors Over 30 Inches in Height: Multipoint.
 - c. Identical keylocks, with two milled keys each lock.
 8. Circuit Directory: Metal frame with transparent plastic face and enclosed card on interior of door.
- G. Bus Bar:
 1. Material: Copper full sized throughout length.
 2. Neutral: Insulated, rated same as phase bus bars with at least one terminal screw for each branch circuit.
 3. Ground: Copper, installed on panelboard frame, bonded to box with at least one terminal screw for each circuit.

4. Lugs and Connection Points:
 - a. Suitable for either copper conductors.
 - b. Solderless main lugs for main, neutral, and ground bus bars.
 - c. Subfeed or through-feed lugs as shown.

H. Circuit Breakers:

1. UL 489.
2. Thermal-magnetic, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle.
3. Type: Bolt-on circuit breakers in all panelboards.
4. Multipole circuit breakers designed to automatically open all poles when an overload occurs on one pole.
5. Do not use tandem or dual circuit breakers in normal single-pole spaces.

I. Manufacturers:

1. Milbank

2.08 CIRCUIT BREAKER, INDIVIDUAL, 0 TO 600 VOLTS

- A. UL 489 listed for use at location of installation.
- B. Minimum Interrupt Rating: As shown.
- C. Thermal-magnetic, quick-make, quick-break, indicating type showing ON/OFF and TRIPPED indicating positions of operating handle.
- D. Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
- E. Locking: Provisions for padlocking handle.
- F. Enclosure: As specified under Execution.
- G. Interlock: Enclosure and switch shall interlock to prevent opening cover with breaker in the ON position.
- H. Manufacturers:
 1. Eaton.
 2. General Electric Co.
 3. Square D Co.
- I. Legend Plate:
 1. Material: Aluminum.

2. Engraving: Indicating specific function, or as shown.
3. Letter Height: 7/64 inch.

J. Manufacturers and Products:

1. General Electric Co.; Type CR 104P.
2. Square D Co.; Type T.
3. Eaton; Type 10250T.

2.09 TERMINAL BLOCKS

- A. Type: UL 1059. Compression screw clamp, with current bar providing direct contact with wire and yoke, with individual rail mounted terminals. Marking system shall permit use of preprinted or field-marked tags.
- B. Yokes and Clamping Screws: Zinc-plated, hardened steel.
- C. Rating: 600V ac.
- D. Manufacturers:
 1. Weidmuller, Inc.
 2. Ideal.

2.10 SUPPORT AND FRAMING CHANNELS

- A. Carbon Steel Framing Channel:
 1. Material: Rolled, mild strip steel, 12 gauge, ASTM A1011/A1011M, Grade 33.
 2. Finish: Hot-dip galvanized after fabrication.
- B. Manufacturers:
 1. B-Line Systems, Inc.
 2. Unistrut Corp.

2.11 NAMEPLATES

- A. Material: Laminated plastic.
- B. Attachment: Adhesive.
- C. Color: Black, engraved to a white core, or as shown.

D. Engraving:

1. Devices and Equipment: Name or tag shown, or as required.
2. Panelboards:
 - a. Designation.
 - b. Service voltage.
 - c. Phases.
3. Minimum Requirement: Label metering and power distribution equipment, local control panels, junction boxes, motor controls, and transformers.

E. Letter Height:

1. Pushbuttons, Selector Switches, and Other Devices: 1/8 inch.
2. Equipment and Panelboards: 1/4 inch.

2.12 CONDUIT AND FITTINGS

A. Rigid Galvanized Steel Conduit (RGS):

1. Meet requirements of NEMA C80.1 and UL 6.
2. Material: Hot-dip galvanized, with chromated protective layer.

B. PVC Schedule 40 Conduit:

1. Meet requirements of NEMA TC 2 and UL 651.
2. UL listed for concrete encasement, underground direct burial, concealed, or direct sunlight exposure, and 90 degrees C insulated conductors.

C. Flexible Metal, Liquid-Tight Conduit:

1. UL 360 listed for 105 degrees C insulated conductors.
2. Material: Galvanized steel, with an extruded PVC jacket.

D. Fittings:

1. Provide bushings, grounding bushings, conduit hubs, conduit bodies, couplings, unions, conduit sealing fittings, drain seals, drain/breather fittings, expansion fittings, and cable sealing fittings, as applicable.
2. Rigid Galvanized Steel:
 - a. Meet requirements of UL 514B.
 - b. Type: Threaded, galvanized.
 - c. Conduit Bodies: Cast ferrous metal.

3. PVC Conduit:
 - a. Meet requirements of NEMA TC 3.
 - b. Type: PVC, slip-on.
4. PVC-Coated Rigid Galvanized Steel Conduit:
 - a. Meet requirements of UL 514B.
 - b. Fittings: Rigid galvanized steel type, PVC-coated by conduit manufacturer.
 - c. Conduit Bodies: Cast metal hot-dipped galvanized or urethane finish. Cover shall be of same material as conduit body. PVC-coated by conduit manufacturer.
 - d. Finish: 40-mil PVC exterior, 2-mil urethane interior.
 - e. Overlapping pressure sealing sleeves.
 - f. Conduit Hangers, Attachments, and Accessories: PVC-coated.
 - g. Manufacturers:
 - 1) Robroy Industries.
 - 2) Ocal.
 - h. Expansion Fitting Manufacturer and Product: Ocal; Ocal-Blue XJG.
5. Flexible Metal, Liquid-Tight Conduit:
 - a. Metal insulated throat connectors with integral nylon or plastic bushing rated for 105 degrees C.
 - b. Insulated throat and sealing O-rings.

2.13 CONDUIT ACCESSORIES

A. Duct Bank Spacers:

1. Type: Nonmetallic, interlocking, for multiple conduit sizes.
2. Suitable for all types of conduit.
3. Manufacturers:
 - a. Underground Device, Inc.
 - b. Carlon.

B. Identification Devices:

1. Warning Tape:
 - a. Material: Polyethylene, 4-mil gauge with detectable strip.
 - b. Color: Red.
 - c. Width: Minimum 6 inches.
 - d. Designation: Warning on tape that electric circuit is located below tape.
 - e. Identifying Letters: Minimum 1-inch high permanent black lettering imprinted continuously over entire length.

2.14 CONDUCTORS AND CABLES

A. Conductors 600 Volts and Below:

1. Conform to applicable requirements of NEMA WC 71, WC 72, and WC 74.
2. Conductor Type: All circuits stranded copper only.
3. Insulation: Type THHN/THWN, except for sizes No. 6 and larger, with XHHW-2 insulation.
4. Flexible Cords and Cables:
 - a. Type SOW-A/50 with ethylene propylene rubber insulation in accordance with UL 62.
 - b. Conform to physical and minimum thickness requirements of NEMA WC 70.

B. 600-Volt Rated Cable:

1. Type TSP, No. 16 AWG, Twisted, Shielded Pair, Instrumentation Cable: Single pair, designed for noise rejection for process control, computer, or data log applications meeting NEMA WC 55 requirements.
 - a. Outer Jacket: 45 mils nominal thickness.
 - b. Individual Pair Shield: 1.35 mils, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
 - c. Dimension: 0.31-inch nominal outside diameter.
 - d. Conductors:
 - 1) Bare soft annealed copper, Class B, seven-strand concentric, meeting requirements of ASTM B8.
 - 2) 20 AWG, seven-strand tinned copper drain wire.
 - 3) Insulation: 15 mils nominal PVC.
 - 4) Jacket: 4 mils nominal nylon.
 - 5) Color Code: Pair conductors black and red.
 - e. Manufacturer: Okonite Co.

C. Accessories:

1. Tape:
 - a. General Purpose, Flame Retardant: 7 mils, vinyl plastic, Scotch Brand 33, rated for 90 degrees C minimum, meeting requirements of UL 510.
 - b. Flame Retardant, Cold and Weather Resistant: 8.5 mils, vinyl plastic, Scotch Brand 88.
 - c. Arc and Fireproofing:
 - 1) 30 mils, elastomer.

- 2) Manufacturers and Products:
 - a) 3M; Scotch Brand 77, with Scotch Brand 69 glass cloth tapebinder.
 - b) Plymount; Plyarc 53, with Plyglas 77 glass cloth tapebinder.
2. Identification Devices:
 - a. Sleeve-type, permanent, PVC, yellow or white, with legible machine-printed black markings.
 - b. Manufacturer and Product: Raychem; Type D-SCE or ZH-SCE.
3. Connectors and Terminations:
 - a. Nylon, Self-Insulated Crimp Connectors:
 - 1) Manufacturers and Products:
 - a) Thomas & Betts; Sta-Kon.
 - b) Burndy; Insulug.
 - c) ILSCO.
 4. Self-Insulated, Freespring Wire Connector (Wire Nuts):
 - a. Plated steel, square wire springs.
 - b. UL Standard 486C.
 - c. Manufacturers and Products:
 - 1) Thomas & Betts.
 - 2) Ideal; Twister.
 5. Cable Lugs:
 - a. In accordance with NEMA CC 1.
 - b. Rated 600 volts of same material as conductor metal.
 - c. Uninsulated Crimp Connectors and Terminators:
 - 1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
 - 2) Manufacturers and Products:
 - a) Thomas & Betts; Color-Keyed.
 - b) Burndy; Hydent.
 - c) ILSCO.
 - d. Uninsulated, Bolted, Two-Way Connectors and Terminators:
 - 1) Manufacturers and Products:
 - a) Thomas & Betts; Locktite.
 - b) Burndy; Quiklug.
 - c) ILSCO.
 6. Cable Ties:
 - a. Nylon, adjustable, self-locking, and reusable.
 - b. Manufacturer and Product: Thomas & Betts; TY-RAP.
 7. Heat Shrinkable Insulation:
 - a. Thermally stabilized, crosslinked polyolefin.
 - b. Manufacturer and Product: Thomas & Betts; SHRINK-KON.

2.15 MOTORS

A. Single-Phase:

1. Provide induction-type unit meeting NEMA MG1 requirements and suitable for application and mounting with the driven load. Motor shall be 115/230V ac, 60 Hz. Provide integral thermal protection and manufacturer's standard insulation system.
2. Horsepower rating: As specified under motor-driven equipment specification.
3. Single-speed: Single-winding. Speed as specified under motor-driven equipment specification.
4. Two-speed: Two-winding; speeds as specified under motor-driven equipment specification.
5. Enclosure: Open drip-proof, unless otherwise noted.

B. Manufacturers:

1. General Electric.
2. Reliance Electric.
3. U.S. Electrical Motors.

2.16 GROUNDING

A. Ground Rods: Provide copper with minimum diameter of 5/8 inch, and length of 12 feet.

B. Ground Conductors: As specified in Article Conductors and Cable.

C. Connectors:

1. Exothermic Weld Type:
 - a. Outdoor Weld: Suitable for exposure to elements or direct burial.
 - b. Indoor Weld: Utilize low-smoke, low-emission process.
 - c. Manufacturers and Products:
 - 1) Erico Products, Inc.; Cadweld and Cadweld Exolon.
 - 2) Thermoweld.
2. Compression Type:
 - a. Compress-deforming type; wrought copper extrusion material.
 - b. Single indentation for conductors 6 AWG and smaller.
 - c. Double indentation with extended barrel for conductors 4 AWG and larger.
 - d. Single barrels prefilled with oxide-inhibiting and antiseizing compound.

- e. Manufacturers:
 - 1) Burndy Corp.
 - 2) Thomas and Betts Co.
 - 3) ILSCO.
- 3. Mechanical Type:
 - a. Split-bolt, saddle, or cone screw type; copper alloy material.
 - b. Manufacturers:
 - 1) Burndy Corp.
 - 2) Thomas and Betts Co.

2.17 RTU CABINETS AND LOCAL CONTROL PANELS

- A. RTU Cabinets: As shown.
- B. Enclosure:
 - 1. NEMA 250, Type 4X, or as shown.
 - 2. Minimum Metal Thickness: 14 gauge.
 - 3. Doors: Rubber gasketed with continuous hinge.
 - 4. Finish: Gray.
 - 5. Size panels to adequately dissipate heat generated by equipment mounted in or on panel.
 - 6. Mount internal and door-mounted devices as shown.
 - 7. Manufacturers:
 - a. Hoffman.
 - b. H. F. Cox.
- C. Functions, Instruments, Interfaces, and Wiring: As shown on instrumentation diagrams and details. Coordinate with Owner requirements.
- D. Wiring:
 - 1. Power and Control Wiring:
 - a. 600-volt class, insulated, stranded copper.
 - b. Size: Minimum 14 AWG enclosed in either sheet metal raceway or plastic wiring duct.
 - 2. Signal Circuit Wiring: Twisted shielded pairs minimum No. 18 AWG, separated at least 6 inches from power wiring.
 - 3. Device Identification: Provide engraved plastic nameplates, adhesive attachment, white letters on black background.

2.18 LUMINAIRES AND ACCESSORIES

- A. Specific requirements relating to fixture type, lamp type, and mounting hardware are provided on Drawings.

2.19 PRESSURE GAUGE

A. General:

1. Function: Local pressure indication.
2. Type: Bourdon tube element.

B. Performance:

1. Scale Range: 0 psig to 300 psig.
2. Accuracy: Plus or minus 0.50 percent of full scale.

C. Features:

1. Dial: 4-1/2-inch diameter.
2. Pointer Vibration Reduction: Required, unless otherwise noted. Use the following method.
 - a. Liquid filled gauge front, unless otherwise noted.
 - 1) Glycerine fill, unless otherwise noted.
3. Case Material: Black thermoplastic, unless otherwise noted.
4. Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components):
 - a. Stainless steel, unless otherwise noted.
5. Pointer: Adjustable by removing ring and window.
6. Window: Glass or acrylic, unless otherwise noted.
7. Threaded reinforced polypropylene front ring.
8. Case Type: Solid front with blow-out back.

D. Process Connection:

1. Mounting: Lower stem, unless otherwise noted.
2. Size: 1/2-inch MNPT, unless otherwise noted.

E. Manufacturers and Products:

1. Ashcroft; Duragauge Model 1259/Model, 1279/Model, 1279 PLUS!
2. Ametek U.S. Gauge; Solfrunt Model 19XX/1981Advantatge.
3. WIKA, Type 2XX.34.

2.20 PRESSURE TRANSMITTER

A. General:

1. Function: Measure pressure and transmit signal proportional to pressure.
2. Type:
 - a. Electronic variable capacitance or silicon strain gauge.

- b. Two-wire transmitter; “smart electronics”.
 - 3. Parts: Transmitter and accessories.
- B. Performance:
 - 1. Range: 0 psig to 300 psig.
 - 2. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
 - 3. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
 - 4. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
 - 5. Humidity: 0 percent to 100 percent relative humidity.
- C. Features:
 - 1. Type: Gauge pressure, unless otherwise noted.
 - 2. Adjustable damping.
 - 3. LCD indicator, unless otherwise noted.
 - a. Display in either percent or engineering units, field configurable.
 - 4. Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
 - a. Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
 - 5. Wetted O-Rings: Glass filled TFE, graphite filled PTFE, or Viton, unless otherwise noted.
 - 6. Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
- D. Process Connections:
 - 1. Line Size: 1/2 inch.
 - 2. Connection Type: FNPT.
- E. Signal Interface:
 - 1. 4 mA dc to 20 mA dc output with digital signal based on HART protocol, unless otherwise noted below.
 - a. Nominal Maximum Loop Resistance with External 24V dc Power Supply: 550 ohms.
- F. Enclosure:
 - 1. Type: NEMA 4X.
 - 2. Materials: Coated aluminum, unless otherwise noted.
 - 3. Mounting bracket, unless otherwise noted.
 - a. Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.

11800 SOUTH U-111 PIPELINE

G. Manufacturer and Product:

1. Gauge Pressure Units: Rosemount; Model 3051TG2A2B21A55.

2.21 LEVEL SWITCH

- A. Provide as shown.

PART 3 EXECUTION

3.01 GENERAL

- A. Install materials and equipment in accordance with manufacturer's instructions and recommendations.
- B. Work shall comply with all applicable provisions of NECA 1.
- C. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned.

3.02 PROTECTION FOLLOWING INSTALLATION

- A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation.
- B. Cap conduit runs during construction with manufactured seals.
- C. Close openings in boxes or equipment during construction.
- D. Energize space heaters furnished with equipment.

3.03 SERVICE ENTRANCE EQUIPMENT AND METERING

- A. Unless otherwise specified or shown, schedule and coordinate work of serving utility as required to provide electric service to the Work.

3.04 OUTLET AND DEVICE BOXES

- A. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
- B. Size:
 1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
 2. Switch and Receptacle: Minimum 2-inch by 4-inch.

- C. Locations:
 - 1. Drawing locations are approximate.
 - 2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Engineer.

- D. Mounting Height:
 - 1. General:
 - a. Dimensions given to centerline of box.
 - b. Where specified heights do not suit building construction or finish, mount as directed by Engineer.
 - 2. Switches: 48 inches above floor, unless otherwise shown on Drawings.
 - 3. Receptacles:
 - a. Industrial Areas: 48 inches above floor, unless otherwise shown on Drawings.

- E. Install plumb and level.

- F. Support boxes independently of conduit by attachment to building structure or structural member.

- G. Box Type (Steel Raceway System):
 - 1. Outdoor Locations: Cast metal.
 - 2. Indoor Locations (Vaults):
 - a. Exposed Raceways: Cast metal.

3.05 JUNCTION AND PULL BOXES

- A. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.

- B. Install pull boxes where necessary in raceway system to facilitate conductor installation.

- C. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

- D. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.

- E. Use conduit bodies as junction and pull boxes where no splices are required and their use is allowed by applicable codes.

- F. Installed boxes shall be accessible.

- G. Install plumb and level.
- H. Support boxes independently of conduit by attachment to building structure or structural member.
- I. At or Belowgrade:
 - 1. Install boxes for belowgrade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
 - 2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
 - 3. Obtain Engineer's written acceptance prior to installation in paved areas, roadways, or walkways.
 - 4. Use boxes and covers suitable to support anticipated weights.
- J. Mounting Hardware:
 - 1. Noncorrosive Indoor Dry Areas and Vaults: Galvanized.
 - 2. Outdoor or Noncorrosive Indoor Wet Areas: Stainless steel.
- K. Location/Type:
 - 1. Indoor and Outdoor, Wet, Including Vaults: NEMA 250, Type 4, fiberglass.
 - 2. Underground Conduit: Concrete.
 - 3. Outdoor, Where Indicated Weatherproof (WP): NEMA 250, Type 3R.
- L. Install Drain/breather fittings in NEMA 250, Type 4 and Type 4X enclosures.

3.06 WIRING DEVICES

- A. Switches:
 - 1. Mounting Height: See Article Outlet and Device Boxes.
 - 2. Install with switch operation in vertical position.
 - 3. Install single-pole, two-way switches such that toggle is in up position when switch is on.
- B. Receptacles:
 - 1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot up.
 - 2. Ground receptacles to boxes with grounding wire only.
 - 3. Weatherproof Receptacles:
 - a. Install in cast metal box.

- b. Install such that hinge for protective cover is above receptacle opening.
- 4. Ground Fault Interrupter: All receptacles specified as GFCI on plans shall be installed as such. No feeding through to conventional receptacles shall be allowed.

3.07 DEVICE PLATES

- A. Securely fasten to wiring device; ensure a tight fit to box.
- B. Surface Mounted: Plate shall not extend beyond sides of box, unless plates have no sharp corners or edges.
- C. Install with alignment tolerance to box of 1/16 inch.
- D. Types (Unless Otherwise Shown):
 - 1. Outdoor: Weatherproof.
 - 2. Indoor:
 - a. Surface Mounted, Metal Boxes: Cast.

3.08 COMBINED METER PEDESTAL

- A. Install securely, plumb, in-line and square with vault.
- B. Install top of cabinet 6 feet above grade, unless otherwise shown.
- C. Provide typewritten circuit directory loadcenter.

3.09 CIRCUIT BREAKERS AND SWITCHES

- A. Location and Enclosure Type: NEMA 250, Type 4.

3.10 SWITCH, MOTOR RATED

- A. Install with switch operation in vertical position such that toggle is in up position when ON.
- B. Install within sight of motor when used as a disconnect switch.
- C. Mounting Height: See Article Outlet and Device Boxes.
- D. Enclosure Type:
 - 1. General Purpose: See Articles Outlet and Device Boxes and Device Plates.

3.11 TERMINAL BLOCKS

- A. Install for termination of control circuits entering or leaving equipment and local control panels.

3.12 SUPPORT AND FRAMING CHANNELS

- A. Install where required for mounting and supporting electrical equipment and raceway systems.
- B. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.13 NAMEPLATES

- A. Provide identifying nameplate on all equipment.

3.14 CONDUIT AND FITTINGS

- A. General:
 - 1. Crushed or deformed raceways not permitted.
 - 2. Maintain raceway entirely free of obstructions and moisture.
 - 3. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.
 - 4. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.
 - 5. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.
 - 6. Group raceways installed in same area.
 - 7. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.
 - 8. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.
 - 9. Block Walls: Do not install raceways in same horizontal course with reinforcing steel.
 - 10. Install watertight fittings in outdoor, underground, or wet locations.
 - 11. Paint threads and cut ends, before assembly of fittings, galvanized conduit, PVC-coated galvanized conduit, installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.
 - 12. Metal conduit to be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.
 - 13. Do not install raceways in concrete equipment pads, foundations, or beams.
 - 14. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

15. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.
16. Install conduits for fiber optic cables, telephone cables, and Category 5 data cables in strict conformance with the requirements of EIA/TIA 569.

B. Installation in Cast-in-Place Structural Concrete:

1. Minimum cover 2 inches, including all fittings.
2. Conduit placement shall not require changes in reinforcing steel location or configuration.
3. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.
4. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns or beams, unless approved by Engineer.
5. Slabs and Walls:
 - a. Trade size of conduit not to exceed one-fourth of the slab or wall thickness.
 - b. Install within middle two-fourths of slab or wall.
 - c. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
 - d. Separate conduit 2 inches and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
 - e. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
 - f. Separate conduit by a minimum six times the outside dimension of expansion and deflection fittings at expansion joints.
 - g. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.
6. Columns and Beams:
 - a. Trade size of conduit not to exceed one-fourth of beam thickness.
 - b. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

C. Conduit Application:

1. Diameter:
 - a. Interior Minimum: 3/4 inch.
 - b. Exterior Minimum: 3/4 inch.
2. Outdoor, Exposed: Rigid galvanized steel.
3. Indoor, Exposed: Rigid galvanized steel.
4. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors: Rigid galvanized steel.
5. Direct Earth Burial: PVC Schedule 40.

D. Connections:

1. For motors-, wall-, or ceiling-mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other equipment where flexible connection is required to minimize vibration:
 - a. General: Flexible metal, liquid-tight conduit.
 - b. Wet Areas: Flexible metal liquid-tight.
 - c. Length: 18 inches minimum, 60 inches maximum, sufficient to allow movement or adjustment of equipment.
2. Lighting Fixtures in Dry Areas: Flexible metal, liquid-tight conduit.
3. Outdoor areas, process areas exposed to moisture, and areas required to be oil-tight and dust-tight: Flexible metal, liquid-tight conduit.
4. Transition From Underground or Concrete Embedded to Exposed: Rigid galvanized steel conduit.
5. Under Equipment Mounting Pads: Rigid galvanized steel conduit.

E. Penetrations:

1. Make at right angles, unless otherwise shown.
2. Notching or penetration of structural members, including footings and beams, not permitted.
3. Fire-Rated Walls, Floors, or Ceilings: Firestop openings around penetrations to maintain fire-resistance rating using fire penetration seals.
4. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack.
5. Entering Structures:
 - a. General: Seal raceway at the first box or outlet with oakum or expandable plastic compound to prevent the entrance of gases or liquids from one area to another.
 - b. Concrete Roof or Membrane Waterproofed Wall or Floor: Provide watertight seal.
 - c. Heating, Ventilating, and Air Conditioning Equipment:
 - 1) Penetrate equipment in area established by manufacturer.
 - 2) Terminate conduit with flexible metal conduit at junction box or conduit attached to exterior surface of equipment prior to penetrating equipment.
 - 3) Seal penetration with one-part polyurethane, immersible sealant.
 - d. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
 - e. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
 - 1) Provide Schedule 40 galvanized pipe sleeve or watertight entrance seal device.

- 2) Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint on each side.
- f. Handholes:
 - 1) Metallic Raceways: Provide insulated grounding bushings.
 - 2) Nonmetallic Raceways: Provide bell ends flush with wall.

F. Support:

- 1. Support from structural members only, at intervals not exceeding NFPA 70 requirements, and in any case not exceeding 8 feet. Do not support from piping, pipe supports, or other raceways.
- 2. Multiple Adjacent Raceways: Provide ceiling trapeze.
- 3. Application/Type of Conduit Strap:
 - a. Steel Conduit: Zinc-coated steel, pregalvanized steel, or malleable iron.
 - b. PVC-Coated Rigid Steel Conduit: PVC-coated metal.
 - c. Nonmetallic Conduit: Nonmetallic or PVC-coated metal.
- 4. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:
 - a. Wood: Wood screws.
 - b. Hollow Masonry Units: Toggle bolts.
 - c. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
 - d. Steelwork: Machine screws.
 - e. Location/Type of Hardware:
 - 1) Dry, Noncorrosive Areas: Galvanized.
 - 2) Wet, Noncorrosive Areas: Stainless steel.

G. Bends:

- 1. Install concealed raceways with a minimum of bends in the shortest practical distance.
- 2. Make bends and offsets of longest practical radius.
- 3. Install with symmetrical bends or cast metal fittings.
- 4. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.
- 5. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.
- 6. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run and raceways are same size.

7. PVC Conduit:
 - a. Bends 30 Degrees and Larger: Provide factory-made elbows.
 - b. 90-Degree Bends: Provide rigid steel elbows, PVC coated where direct buried.
 - c. Use manufacturer's recommended method for forming smaller bends.
 8. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.
- H. Expansion and Deflection Fittings: Provide on all raceways at structural expansion joints and in long tangential runs.
- I. PVC Conduit:
1. Solvent Welding:
 - a. Provide manufacturer recommended solvent; apply to all joints.
 - b. Install such that joint is watertight.
 2. Adapters:
 - a. PVC to Metallic Fittings: PVC terminal type.
 - b. PVC to Rigid Metal Conduit or IMC: PVC female adapter.
 3. Belled-End Conduit: Bevel the unbelled end of the joint prior to joining.
- J. Termination at Enclosures:
1. Cast Metal Enclosure: Provide manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.
 2. Nonmetallic, Cabinets, and Enclosures: Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
 3. Sheet Metal Boxes, Cabinets, and Enclosures:
 - a. Rigid Galvanized Conduit:
 - 1) Provide one lock nut each on inside and outside of enclosure.
 - 2) Install grounding bushing.
 - 3) Provide bonding jumper from grounding bushing to equipment ground bus or ground pad; if neither ground bus nor pad exists, connect jumper to lag bolt attached to metal enclosure.
 - 4) Install insulated bushing on ends of conduit where grounding is not required.
 - 5) Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
 - 6) Utilize sealing locknuts or threaded hubs on outside of NEMA 3R and NEMA 12 enclosures.

- b. Flexible Metal Conduit: Provide two-screw type, insulated, malleable iron connectors.
 - c. PVC-Coated Rigid Galvanized Steel Conduit: Provide PVC-coated, liquid-tight, metallic connector.
 - d. PVC Schedule 40 Conduit: Provide PVC terminal adapter with locknut.
4. Free-Standing Enclosures:
- a. Terminate metal conduit entering bottom with grounding bushing; provide a grounding jumper extending to equipment ground bus or grounding pad.
 - b. Terminate PVC conduit entering bottom with bell end fittings.
- K. Underground Raceways:
- 1. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.
 - 2. Cover: Maintain minimum 2-foot cover above conduit, unless otherwise shown.
 - 3. Make routing changes as necessary to avoid obstructions or conflicts.
 - 4. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.
 - 5. Union type fittings not permitted.
 - 6. Spacers:
 - a. Provide preformed, nonmetallic spacers, designed for such purpose, to secure and separate parallel conduit runs in a trench.
 - b. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.
 - 7. Support conduit so as to prevent bending or displacement during backfilling.
 - 8. Metallic Raceway Coating: Along entire length, coat with raceway coating.
 - 9. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.
 - 10. Provide deflectional/expansion fittings in conduit runs that exit building or structure belowgrade. Conduit from building wall to fitting shall be PVC-coated rigid steel.
 - 11. Backfill: As specified in Section 31 23 23.15, Trench Backfill.
- L. Empty Raceways:
- 1. Provide permanent, removable cap over each end.

2. Provide PVC plug with pull tab for underground raceways with end bells.
3. Provide nylon pull cord.
4. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.15 CONDUCTORS AND CABLES

- A. Conductor storage, handling, and installation shall be in accordance with manufacturer's recommendations.
- B. Do not exceed manufacturer's recommendations for maximum pulling tensions and minimum bending radii.
- C. Conduit system shall be complete prior to drawing conductors. Lubricate prior to pulling into conduit. Lubrication type shall be as approved by conductor manufacturer.
- D. Terminate all conductors and cables, unless otherwise shown.
- E. Do not splice conductors, unless specifically indicated or approved by Engineer.
- F. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches.
- G. Wiring within Equipment and Local Control Panels: Remove surplus wire, dress, bundle, and secure.
- H. Power Conductor Color Coding:
 1. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering an area 1-1/2 inches to 2 inches wide.
 2. No. 8 AWG and Smaller: Provide colored conductors.
 3. Colors:
 - a. Neutral Wire: White.
 - b. Live Wires, 120/240-Volt, Single-Phase System: Black, red.
 - c. Ground Wire: Green.
- I. Circuit Identification:
 1. Assign circuit name based on device or equipment at load end of circuit. Where this would result in same name being assigned to more than one

circuit, add number or letter to each otherwise identical circuit name to make it unique.

2. Method: Identify with sleeves. Taped-on markers or tags relying on adhesives not permitted.

J. Connections and Terminations:

1. Do not wrap strand conductors around screws. Use crimp connectors.
2. Install nylon self-insulated crimp connectors and terminators for instrumentation and control circuit conductors.
3. Tape insulate all uninsulated connections.
4. Install crimp connectors and compression lugs with tools approved by connector manufacturer.

3.16 GROUNDING

- A. Grounding shall be in compliance with NFPA 70 and as shown.
- B. Ground electrical service neutral at service entrance equipment to supplementary grounding electrodes.
- C. Ground each separately derived system neutral to nearest effectively grounded building structural steel member or separate grounding electrode.
- D. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways and ground conductor in raceways and cables.
- E. Shielded Instrumentation Cables:
 1. Ground shield to ground bus at RTU for analog signal.
 2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
 3. Do not ground instrumentation cable shield at more than one point.
- F. Equipment Grounding Conductors: Provide in all conduits containing power conductors and control circuits above 50 volts.
- G. Ground Rods: Install full length with conductor connection at upper end. Install one ground rod in each handhole.

3.17 LUMINAIRES AND ACCESSORIES

- A. Install in accordance with manufacturer's recommendations.
- B. Install plumb and level at mounting heights shown.

- C. Provide proper hangers, pendants, and canopies as necessary for complete installation and meeting specified seismic requirements.
- D. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

3.18 PRESSURE AND LEVEL INSTRUMENTS

- A. Install, calibrate, and field test in accordance with manufacturer instructions.

3.19 FIELD QUALITY CONTROL

- A. Tests shall be performed in accordance with the requirements of Section 01 91 14, Equipment Testing and Facility Startup.
- B. General:
 - 1. Test equipment shall have an operating accuracy equal to, or greater than, requirements established by NETA ATS.
 - 2. Test instrument calibration shall be in accordance with NETA ATS.
 - 3. Perform inspection and electrical tests after equipment has been installed.
 - 4. Perform tests with apparatus de-energized whenever feasible.
 - 5. Inspection and electrical tests on energized equipment are to be:
 - a. Scheduled with Engineer prior to de-energization.
 - b. Minimized to avoid extended period of interruption to the operating plant equipment.
- C. Tests and inspection shall establish that:
 - 1. Electrical equipment is operational within industry and manufacturer's tolerances.
 - 2. Installation operates properly.
 - 3. Equipment is suitable for energization.
 - 4. Installation conforms to requirements of Contract Documents and NFPA 70.
- D. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.
- E. Adjust mechanisms and moving parts for free mechanical movement.
- F. Adjust adjustable relays and sensors to correspond to operating conditions, or as recommended by manufacturer.
- G. Verify nameplate data for conformance to Contract Documents.

- H. Realign equipment not properly aligned and correct unlevelness.
- I. Properly anchor electrical equipment found to be inadequately anchored.
- J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench to manufacturer's recommendations, or as otherwise specified.
- K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.
- L. Provide proper lubrication of applicable moving parts.
- M. Investigate and repair or replace:
 - 1. Electrical items that fail tests.
 - 2. Active components not operating in accordance with manufacturer's instructions.
 - 3. Damaged electrical equipment.
- N. Electrical Enclosures:
 - 1. Remove foreign material and moisture from enclosure interior.
 - 2. Vacuum and wipe clean enclosure interior.
 - 3. Remove corrosion found on metal surfaces.
 - 4. Repair or replace, as determined by Engineer, door and panel sections having damaged surfaces.
 - 5. Replace missing or damaged hardware.
- O. Document the successful completion of specified testing.
- P. Test the following equipment and materials:
 - 1. Conductors: Insulation resistance, No. 4 and larger only.
 - 2. Panelboards, switches, and circuit breakers.
 - 3. Motor controls.
 - 4. Grounding electrodes.
 - 5. Motors.
- Q. Controls:
 - 1. Test control and signal wiring for proper termination and function.
 - 2. Test local control panels and other control devices for proper terminations, configuration and settings, and functions.
 - 3. Demonstrate control, monitoring, and indication functions in presence of Owner and Engineer.

- R. Balance electrical load between phases on panelboards and mini-power centers after installation.
- S. Voltage Testing:
 - 1. When installation is complete and facility is in operation, check voltage at point of termination of electric utility supply system to Project.
 - 2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
 - 3. Record supply voltage for 24 continuous hours.
 - 4. If unbalance exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded conditions more than plus or minus 4 percent of nominal, make written request to electric utility to correct condition.
 - 5. If corrections are not made, obtain written statement from a responsible electric utility official that voltage variations and/or unbalance are within their normal standards.
- T. Equipment Line Current:
 - 1. Check line current in each phase for each piece of equipment.
 - 2. If electric utility makes adjustments to supply voltage magnitude or balance, make line current check after adjustments are made.

END OF SECTION