SECTION 8
ELECTRICAL – BASIC MATERIALS AND METHODS

8.01 Scope of Work: Work covered by this Specification consists of furnishing all labor, equipment, supplies and materials, and performing all operations including cutting, trenching and backfilling, etc., necessary for the installation of complete wiring systems as shown on Drawings and as hereinafter specified.

Work shall include power distribution and controls, lighting systems, instrumentation and metering, wiring and telephone service (where required).

8.02 Quality Assurance: Installation shall comply with all laws applicable to electrical installations which are enforced by local authorities, with the regulations of National Electrical Code where such regulations do not conflict with local laws, and with regulations of the utility company that serves the facility. Contractor shall obtain all permits required by local authorities and, after completion of work, and shall furnish Engineer and Owner a certificate of final inspection and approval from inspection bureau having jurisdiction. Contractor shall notify Engineer and Owner that certificate has been furnished to utility company so that application for service can be filed.

All materials shall be new and shall bear a U.L. label or be listed by Underwriter's Laboratories as conforming to its standards where such a standard has been established for the particular type of material in question.

Catalog numbers of devices, fixtures, equipment, etc., are used for ease in describing standard of quality desired. Devices, fixtures, equipment, etc., by other manufacturers performing the same functions and considered equal in quality by the Engineer will be acceptable.

8.03 Reference: All work shall conform to applicable standards of ANSI, ICEA, IEEE, ISA, NEMA, UL and NEC.

8.04 Submittals:

A. Contractor's submittal shall include a list of manufacturers of principal items of equipment and material including wire, raceways, devices, boxes, panelboards, connectors, etc. Full information shall be furnished on products of manufacturers not named in the Contract Documents.

B. Shop drawings shall be submitted giving performance data, physical size, wiring diagrams, materials, etc., for control centers, lighting fixtures, motor controllers, panelboards, conduit and duct, and cable and wire.

C. The requirements of each electrical system shall be identified by the Contractor before submission of shop drawings, and all necessary accessory parts required between items of electrical equipment shall be identified in sufficient detail to prove that the total equipment furnished and installed will operate as specified and shown on the Drawings.

D. Shop drawings and samples shall be thoroughly checked and coordinated by the Contractor for details and fulfillment of Contract requirements prior to submittal.

Approval of any item does not relieve Contractor of responsibility for coordinating dimensions and work required by other trades.

E. Refer to the General Requirements section of these Specifications for submittal requirements and quantities.

8.05 Delivery, Storage and Handling: All materials shall be unloaded and stored in a manner to avoid physical damage or detrimental effects of exposure to weather.

8.06 Grounding: All equipment, building steel and main service must be effectively and permanently grounded with a cross section as required by the NEC and of capacity sufficient to ensure effectiveness of the ground connections for fault current. Ground conductors must be as short and straight as possible and protected from mechanical injury, if practical, without splice or joint.

A. Grounding Conductors:

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

2. Main service conduits, entering switchgear, panels, control center, switches, etc., shall be provided with insulating bushings with ground lug and connected to building ground system.

3. Bonding jumpers shall be copper tape, braided conductors, terminated with copper ferrules sized in accordance with the National Electrical Code table on sizes of equipment grounding electrode conductors.

4. All flexible conduits making final connections to motors, lights, vibrating equipment, etc., shall contain a green copper bonding conductor which shall extend from outlet box where flexible conduit originates or from nearest box in line to the equipment served.

B. Devices: Each receptacle and switch device shall be furnished with a grounding screw connected to the metallic device frame. Bond equipment grounding conductor to each outlet box. For isolated ground receptacles, bond equipment grounding conductor to box, and bond isolated ground conductor to device grounding screw.

C. Ground Rods: Ground rods shall be a minimum of ⅝" in diameter by 10' long, with a copper jacket bonded to a steel core.

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

E. Raceways, boxes, outlets, cabinets, etc., shall be bonded together to form a continuous metallic grounding circuit in accordance with NEC.

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

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

8.07 Equipment Identification:

A. Engraved Plastic Nameplates: Nameplates shall be engraving stock, melamine plastic laminate, minimum 1/16" thick plates with engraved white letters on black face legend. Painted, stenciled or indented tape identification is not acceptable.

B. Item Identification: Install identification on each unit of equipment, including central or master unit of each system. Power, lighting, communication, signal and alarm systems shall be furnished with identification unless units are specified with their own self-explanatory identification.

1. Unless otherwise indicated, provide a single line of text with ½" high lettering on 1½" high label; where 2 lines of text are required, use labels 2" high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:

2. All electrical apparatus such as wiring troughs, panelboards, switchgear, switchboards, motor control centers, enclosed circuit breakers, electrical cabinets and enclosures, motor starters, push-button stations, contactors, transformers and disconnect switches shall have laminated plastic identification plates. Identification shall match labeling shown on Drawings.

3. Circuit breakers and disconnects shall identify the equipment served and circuit and panel from which it is served.

8.08 Cables and Conductors:

A. All conductors shall be type THHN-THWN #12 AWG minimum, insulated, color coded, and in accordance with ASTM B3, B8 and B787, UL 83, 758,1063 and 1581.

B. Instrument Cable: Cable for electronic circuits to instrumentation, metering and other signaling and control equipment shall be 2 or 3 conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield.

C. Installation:

1. Conceal cables in finished walls, ceilings and floors unless otherwise indicated.

2. Conductor splices and connections shall be made with approved solderless lugs and mechanical connections to ensure positive electrically and mechanically strong joints. Use of connectors without internal spiral spring (wire nuts) is not acceptable.

3. Where bolted connectors are used for makeup of cables or for termination, they must be exact size to suit cable being used. Trimming, shimming or cutting of conductor strands are not permitted. Where branch circuit conduits are jointed or spliced using crimp-on or twist-on connectors, wires must first be twisted together full length and then connector installed.

4. Conductors within switchboards, panelboards, terminal cabinets, starters, control centers, etc., shall be neatly formed and trained to run parallel to or at right angles to the device. Conductors shall be bundled together and laced using nylon tie straps.

5. Use pulling means, including fish tape, cable, rope and basket-weave wire/cable grips, that will not damage cables or raceway.

6. Control cable shall be minimum #14 AWG single or multiple conductor, 600V insulation.

7. Control raceway and wiring shall be installed and fully connected to make system operational.

8.09 Junction and Pull Boxes: Pull boxes no less than the minimum size required by the National Electrical Code Article 370 shall be constructed of cast aluminum with gasketed covers. Boxes shall be furnished with screw fastened covers. Boxes located on the exterior of the structures shall be watertight. Covers shall be secured with tamper proof screws. Boxes and outlets shall be cast alloy type and securely attached to building structure using expansion bolts for masonry or concrete construction.

A. Cabinets: Galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel may be provided where approved. Cabinets shall include the following:

1. Hinged door in front cover with flush latch and concealed hinge

2. Key latch to match panelboards

3. Include metal barriers to separate wiring of different systems and voltage and includes accessory feet where required for freestanding equipment.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Handholes and boxes shall be molded sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

C. Precast Concrete Electric Manhole: Precast concrete electrical manholes shall include thin-wall knockout, pull irons, sump box with grate, ground rod sleeve, fiberglass ladder, neck extension, where required, and a cast or ductile iron ring and cover marked "ELECTRIC".

D. All outlet or junction boxes of pressed or sheet steel type shall be galvanized, sheradized, bonderized or treated with a similar approved corrosion inhibitor.

E. Installation:

1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

2. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets. Conduits shall be concealed where practicable.

3. Covers and collars for manholes shall be level with the finished grade. Build up masonry wall between manhole top and manhole cover collar as required for leveling with finished grade.

8.10 Raceways: All raceways shall conform to Underwriter's Laboratories and NEMA standards and be fully UL labeled. Contractor shall be responsible for routing all conduits, including all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on Drawings, it shall be considered a general guideline and shall be field verified to avoid interferences.

A. Submittals: Submit manufacturer's literature for each type of conduit or tubing and fittings used in the project in accordance with the General Requirements of these Specifications.

B. Manufacturers:

1. Acceptable manufacturers of rigid galvanized steel, aluminum and electrical metallic tubing conduit are: Allied Tube and Conduit Co., Wheatland Tube Co., Triangle, L.T.V., American Brass, E.T.P., Robroy or equal.

2. Acceptable manufacturers of polyvinyl chloride (PVC) conduit are: Allied Tube and Conduit Co., Certainteed, Georgia Pipe, Carlon, Cantex, Queen City or equal.

3. Acceptable manufacturers of PVC coated rigid galvanized conduit and fittings are: Plasti-bond Red H_2OT, Calbond or equal.

4. Acceptable manufacturers of liquid tight flexible metal conduit and fittings are: Electric-Flex Company, Hubbell, Ideal Industries, Southwire or equal.

5. Acceptable manufacturers of conduit fittings, bushings, and locknuts are: O-Z/Gedney, Thomas and Belts, Raco or equal.

C. Wiring: All wiring shall be in a raceway or conduit, and the following shall govern type used throughout the project except as otherwise specified:

1. Rigid Galvanized Steel or Aluminum Conduit: Use for all exposed indoor raceways except as otherwise noted. Exposed conduit shall be rigidly supported by hot-dip galvanized or aluminum hardware and framing materials. Conduit shall be listed UL 6 (6A) and be manufactured in accordance with ANSI C80.1 (C80.5).

2. Electrical Metallic Tubing (EMT): Use for all concealed raceways in ceilings and walls. EMT galvanized raceways shall have a sheradized, bonderized, galvanized or similar approved coating. Conduit shall be listed UL 797 and be manufactured in accordance with ANSI C80.3.

3. Liquid-Tight Flexible Steel Conduit: Use for final connections, maximum 72", to all dry-type transformers, motors, vibrating equipment and in wet or damp installations. Outer covering shall be polyvinyl chloride, and inner core shall be galvanized steel. Provide UL listed watertight connectors installed without sharp bends.

4. Rigid Non-Metallic PVC Plastic Conduit: Use for outside underground for feeders and branch circuits except as otherwise noted and where specifically indicated on Drawings. A grounding conductor shall be installed in each non-metallic conduit to maintain grounding continuity. Follow manufacturer's recommendations for heat bends and cement application. Install plastic to rigid adapter before emerging from ground or running under building. Install expansion fittings for each 100' of unbroken PVC run. Rigid non-metallic PVC plastic raceways shall be listed UL 651 and be manufactured in accordance with NEMA TC2.

5. Rigid, PVC Coated Galvanized Conduit: Use for all exposed outdoor raceways and corrosive environments (RAS pump station, chemical feed and storage rooms, sludge dewatering building). PVC coated galvanized steel conduit shall be listed in accordance to UL6 & ANSI C80.1. The conduit shall be hot dipped galvanized inside and out with hot galvanized threads. The exterior PVC coating shall have a series of longitudinal ribs 40 mils thick to protect from damage during installations. All threaded connections shall be urethane coated. Interior and threaded connection urethane coating shall be a nominal 2 mil thickness. Mounting hardware, which includes nuts, bolts, and anchors, shall be PVC coated or stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

D. Accessories:

1. Sleeves: Sleeves shall be cast or fabricated wall pipe, equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2. Sleeve Seals: Sleeve seals shall be a modular sealing device and designed for field assembly to fill annular space between sleeve and cable.

3. Stainless Steel Pressure Plate: Include 2 for each sealing element and include stainless steel bolts and nuts of length required to secure pressure plates to the sealing elements.

4. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other fittings to match and mate with wire ways required for complete system. All couplings and

connections in locations where water or other liquid or vapor might contact the conduit shall be watertight.

5. Conduit Boxes: Exposed conduit boxes and pulling elbows shall be of die-cast aluminum with threaded body and removable gasketed cover.

6. Duct Sealant: Duct sealant shall be Polywater FST™ Foam Sealant. Duct sealant shall be a 2-part, 98% closed-cell urethane foam. It shall react and set in 5 to 10 minutes at 70°F. It shall be capable of sealing ¾" to 10" conduits with multiple cable configurations. Duct sealant shall be re-enterable. It shall be capable of withstanding temperatures from -40°F to 200°F and be chemically resistant to gasoline, oils, dilute acids and bases. Duct sealant shall not affect the physical or electrical properties of wire and cable.

   Duct sealant shall provide good adhesion to duct and cable jacket surfaces with good structural strength. It shall have 120 pound compressive strength (ASTM D1621). Duct sealant shall be capable of holding 22' waterhead pressure continuous or 90' waterhead pressure short-term. It shall block up to 5 psi gas or vapor continuous. It shall meet NEC codes for raceway seals, meet UL 94 fire rating HBF and be UL recognized.

E. Installation:

1. Keep raceways at least 12" away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

2. Complete raceway installation before starting conductor installation.

3. All raceway stubs shall be sufficiently plugged or capped during construction to prevent entry of water, debris, mortar, etc.

4. Where non-metallic PVC plastic conduit is installed underground in groups of 3 or more, it shall be installed in duct banks as indicated on the Drawings. Duct banks shall be encased in 3,000 psi concrete with red dye added.

5. All conduits entering boxes, cabinets, panels of similar equipment shall have double locknuts and insulating bushing.

6. In all liquid-tight flexible steel conduit, provide a green grounding conductor sized per NEC. Bond at fixture, motor, etc., and also bond at box where flexible conduit originates or the next box in line.

7. A code sized grounding conductor shall be installed in all raceways.

8. All raceways shall be rigidly supported from building structure by rods or hangers attached to building structure. Raceways shall not be attached to any rods or hangers required by other trades. Raceways shall be supported from building construction at intervals as required by the NEC not to exceed 8' with straps and expansion bolts for masonry or concrete construction.

9. All raceways entering cabinets, panels, switchboxes, switchgear, junction boxes, etc. shall be fitted with double bonding locknuts and bushings. One

locknut inside and one outside box shall be used. Where conduits terminate in steel or cast NEMA enclosures with no factory installed threaded hubs, a threaded hub shall be installed.

10. Feeder cable conductors shall be pulled into raceways using an approved soapstone product lubricant. Pull conductors with a pulling eye attached to conductor so not to stretch or injure insulation.

    a. Contractor shall be responsible for coordinating proper connection at each item of equipment requiring service and connect accordingly. The term "stub-up and connect" or "connect" used on Drawings implies a full connection as required for each piece of equipment to place it in satisfactory operation. If equipment is equipped with cord and plug, install proper matching receptacle.

    b. All aluminum conduit installed in contact with concrete or earth shall be protected with aluminum bitumastic paint or tape wraps approved for the purpose.

    c. Conceal conduit within finished walls, ceilings and floors unless otherwise indicated. Install concealed raceways with a minimum of bends in the shortest practical distance considering type of building construction and obstructions, unless otherwise indicated.

    d. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 pound tensile strength. Leave at least 12" of slack at each end of pull wire.

8.11 Wiring Devices: Metallic and nonmetallic conduit boxes and fittings shall be installed in the following locations:

A. Switches: Switches shall be specification grade, totally enclosed, brown composition, back and side wired, 20 amp, 227V and comply with UL 20.

1. Manufacturer:

    a. Hubbell: CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224(four way)

    b. Leviton: 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way)

    c. Pass & Seymour: 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way)

    d. or equal

2. Switches shall be installed 4' above floor to top of boxes except as otherwise noted.

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

B. Receptacles: All receptacles shall conform to current NEMA configurations and be UL listed.

1. Duplex Wall Receptacle: Duplex wall receptacles shall be of grounding pole type, 125 V., 20 amperes, brown composition, back and side-wired and comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498. Acceptable manufacturers are: Hubbell: HBL5351 (single), CR5352 (duplex), Leviton: 5891 (single), 5352 (duplex), Pass & Seymour: 5381 (single), 5352 (duplex), or equal.

2. GFCI Receptacles: Receptacles shall be straight blade, non-feed-through type, shall include device trip indicator light, and comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A. Acceptable manufacturers are: Hubble: GF20, Leviton: AGTR2, Pass & Seymour: 2084, or equal.

3. Receptacles shall be installed vertically 1'-4" above the floor except as noted otherwise.

4. Outlets outdoors and in garages, basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4' above floor or grade.

5. Conduit and wire for receptacle installation not shown on the Drawings shall be, sized, furnished and installed by Contractor. Conductors shall be minimum 12 AWG, and conduit shall be minimum ¾" for convenience outlet installation.

C. Cover Plates: Provide and install single and combination types to match corresponding wiring devices. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

1. Plate-Securing Screws: Metal with head color to match plate finish

2. Material for Finished Spaces: 0.05" thick anodized aluminum

3. Material for Unfinished Spaces: Galvanized steel

4. Material for Wet Locations: Weatherproof covers for duplex receptacles shall be NEMA 3R weather resistant die-cast aluminum with spring loaded lift and lockable cover.

D. Installation:

1. Install devices and assemblies level, plumb and square with building lines.

2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top. Group adjacent switches under single, multi-gang wall plates.

3. Remove wall plates and protect devices and assemblies during painting.

4. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

E. Testing: After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements. Test GFCI operation with both local and remote fault simulations according to manufacturer's instructions.

8.12 Panelboards: The Contractor shall furnish and install the panelboards as specified and as shown on the Drawings. The panelboards and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA PB-1 and UL 67. Panelboards shall be manufactured by ABB, Eaton, GE, Square D, or equal.

A. Submittals: The following information shall be submitted to the Engineer in accordance with the General Requirements section of these Specifications: breaker layout drawing with dimensions indicated and nameplate designation, component list, conduit entry/exit locations, cable terminal sizes, product data sheets, assembly ratings including: short-circuit rating, voltage, continuous current.

B. Ratings: Panelboards rated 240 VAC or less shall have short-circuit ratings as shown on the Drawings or panelboard schedules, but not less than 10,000 amperes RMS symmetrical. Panelboards rated 480 VAC shall have short-circuit ratings as shown on the Drawings or panelboard schedules, but not less than 14,000 amperes RMS symmetrical. Panelboards shall be labeled with a UL short-circuit rating.

C. Construction: Interiors shall be completely factory assembled. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors. Trims for branch circuit panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Door-in-door trim shall be provided. Distribution panelboard trims shall cover all live parts. A directory card with a clear plastic cover shall be supplied and mounted on the inside of each door.

D. Bus: Main bus bars shall be copper, sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 65° C above an ambient of 40° C maximum. A system ground bus shall be included in all panels. Full-size (100%-rated) insulated stand-off neutral bars shall be included for panelboards shown with neutral. Bus bar taps for panels with single-pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral busing shall have a suitable lug for each outgoing feeder requiring a neutral connection.

E. Branch Circuit Panelboards Circuit Breakers: The minimum short-circuit rating for branch circuit panelboards shall be 10,000 amperes symmetrical at 240 volts, and 14,000 amperes symmetrical at 480 volts, or as indicated on the Drawings. Panelboards shall be fully rated. All circuit breakers shall be thermal-magnetic type with common handle for all multiple pole circuit breakers. Circuit breakers shall be minimum 100-ampere frame. Ratings through 100-ampere trip shall take up the same pole spacing. Circuit breakers shall be UL listed as type SWD for lighting circuits.

F. Distribution Panelboards Circuit Breakers: Distribution panelboards equipped with bolt-on devices shall have interrupting ratings as indicated on the Drawings. Panelboards shall be fully rated. Panelboards shall have molded case circuit breakers as indicated below. Where indicated, provide circuit breakers UL listed for application at 100% of their continuous ampere rating in their intended enclosure. Main breakers with 1200A frames, if furnished, shall be equipped with microprocessor based trip units that have integral arc flash reduction trip feature.

Distribution circuit breakers shall be fixed mounted type and equipped with either microprocessor based trip units or thermal magnetic trip units as scheduled on the contract Drawings. Provide shunt trips, bell alarms, and auxiliary switches as shown on the contract drawings.

G. Surge Protective Devices (SPD): Where shown on the Drawings, provide an integral SPD as specified in the contract Documents.

H. Enclosures: Enclosures shall be at least 20" wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least 4 interior mounting studs with adjustable nuts shall be provided. Enclosures shall be provided with blank ends.

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

J. Installation: The Contractors shall install all equipment per the manufacturer's recommendations and the Drawings.

8.13 Safety Switches: The Contractor shall furnish and install heavy duty rated low-voltage fused and non-fused switches as specified herein and as shown on the Drawings. The switches and all components shall be designed, manufactured and tested in accordance with the latest applicable version of NEMA and UL standards. Provide switches rated for the voltage, current and NEMA enclosure rated for the environment as shown on the Drawings. Switches shall be manufactured by ABB, Eaton, GE, Square D, or equal.

8.14 Dry Type Transformer: The Contractor shall furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers of the two-windings type, self-cooled as specified herein, and as shown on the Drawings. Transformers shall be manufactured by ABB, Eaton, GE, SolaHD, Square D, or equal.

The kVA and voltage ratings shall be as indicated on the Drawings. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment". Transformers efficiency shall be measured according to federal law 10 CFR Part 431. Transformer sound levels shall not exceed the ANSI and NEMA levels for self-cooled ratings.

A. Taps: Three-phase transformers shall be provided with six 2½% taps: two above and four below rated primary voltage.

B. Enclosure: The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90° C per UL requirement. The core of the transformer shall be grounded to the enclosure.

C. Factory Testing: The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.

D. Installation: The Contractors shall install all equipment per the manufacturer's recommendations and the Drawings.

8.15 Lighting Fixtures: Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. Lighting fixtures submitted as equal to those in the schedule without accompanying equivalent digital IES photometric data will be rejected. Lighting fixtures shall be furnished complete with lamps, ballast and/or LED drivers as required for proper operation.

A. Installation: Provide and install mounting system compatible with ceiling system shown on the Drawings. Coordinate fixtures, mounting hardware, and trim with ceiling system and other items, including work of other trades required to be mounted on ceiling or in ceiling space. The fixture installation shall comply with applicable local code requirements of the authority having jurisdiction and the NEC. Contractor is responsible for the proper support and mounting of lighting fixtures in accordance with NEC Article 410 Part IV. If required, lighting fixtures shall be provided with disconnects in accordance with NEC requirements.

B. Adjusting and Cleaning: Clean interior lighting fixtures of dirt and construction debris upon completion of installation. Install all fuses. Clean fingerprints and smudges from lenses and lamps. Use methods and materials recommended by manufacturer. All lighting fixtures shall be clean at time of final acceptance. Adjust aimable fixtures to provide required light intensities.

8.16 Execution:

A. Inspection: Inspect preceding work to ensure satisfactory completion prior to electrical work.

B. Preparation: Coordinate work with power company and Owner to minimize delays in operation of new facilities.

C. Wiring layouts or schematics are not intended to show exact location of raceways, outlets, etc. Contractor shall refer to building plans and details for dimensions and shall fit his work to conform to details of building construction. The right is reserved to shift any switch, receptacle, ceiling or other outlet a maximum of 10' from its location as shown on Drawings before it is permanently installed without incurring additional expense.

8.17 Lighting Contactor: Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be non-combination mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 30 amperes, 600 volts ac, for all types of loads. Contactors shall be Eaton C30CN, GE CR460, Square D Class 8903 or equal.

A. Contactor Control Panel: Contactor control panel shall be UL 508A listed and NEMA 3R rated for the environment unless noted otherwise. The short circuit

current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

B. Lighting Control: Enclosed lighting control shall be provided with control power transformer and HOA selector switch.

C. Photoelectric Controls: Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

8.18 Installation: Contractor shall furnish all labor and furnish, install, connect, test and adjust all equipment and materials to form a complete operating installation, including wiring hangers, supports for equipment, cables, conduits, cable tray, cable trench, pull boxes anchors and inserts, identification plates, signs, and tags for equipment, conduits, wiring and wiring labels.

A. The electrical work shall be installed in such a manner and at such times as will require a minimum of cutting and patching of the building structure.

B. Provide all wiring for testing and trials, for all required corrections, changes, additions, completions and adjustments until final acceptance of the work.

C. Coordinate numbers and label all field wiring between equipment of the various electrical equipment suppliers.

D. Any damage to work already in place as a result of electrical work shall be repaired and made good at no expense to the Owner.

8.19 Testing and Acceptance: Prior to acceptance by the Owner, all control systems shall function as required, and all motors shall be connected to protective devices and control devices associated with a machine or a group of machines to produce the correct operating, timing and sequencing necessary for the proper functioning of the mechanical equipment.

8.20 As-Built Drawings: Submit one blueline print of the Drawings marked to show as-built locations and description of all electrical work.

8.21 Payment: No separate payment will be made for the work of this Section. The cost of the work, and all costs incidental thereto, shall be included in the price bid for the item to which the work pertains.